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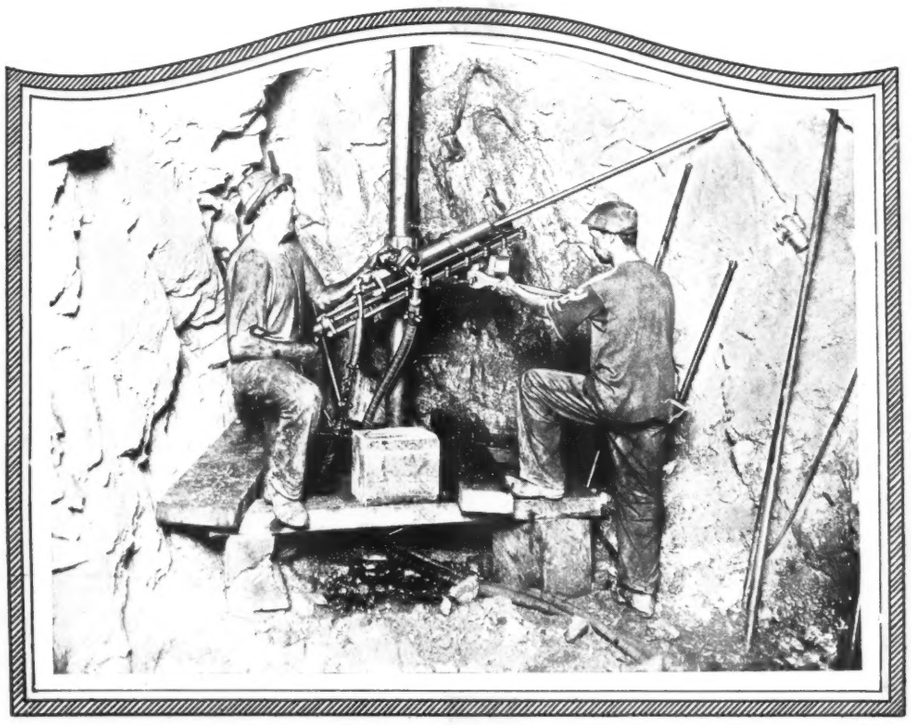

OPERATING AIR DRILLS, THE FIRST STAGE IN BREAKING ORE AT ANACONDA COPPER COMPANY'S MINES IN BUTTE, MONT.

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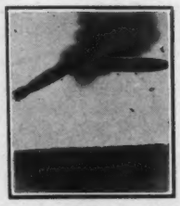
NOVEMBER, 1921

Why America Leads in Production of Helium

A Chapter of Wartime Endeavor of Which the General Public Knows but Little—Production of Helium Gas in Large Quantities will Mark an Important Advance in Commercial Aviation

By ROBERT G. SKERRETT



THE SUDDEN and violent destruction of the great dirigible ZR-2, while circling far aloft over Hull, England, on the 24th of August, quite naturally appalled the peoples of the two nations most concerned in that disaster. With a personnel of 49 aboard, all but five of them perished, and of the victims seventeen were of the American Naval Aviation force and the rest of them mainly of the kindred branch of the British fleet. It is probably not an exaggeration to say that all of these sacrifices were the outcome of splendid and courageous efforts to advance the science of mechanical flight. The particularly distressing aspect of the catastrophe lay in the fact that the fatalities might have been far fewer had it been possible to have taken advantage of the brilliant wartime work of certain of our chemists.

Admitting that the ZR-2 was structurally weak in any respect and that her collapse under atmospheric stresses was foredoomed, still the crumpling of her framework when 1,000 feet above the earth, need not in itself have meant the death of so large a number of her passengers. Undoubtedly most of the men killed died as the direct result of the thunderous explosions of the craft's hydrogen-filled gas bags. The detonations were violent enough to shatter the windows of hundreds of the buildings in the town below. The wonder is that any of the men on the airship escaped the blasts and the withering flames.

The calamity was the climax of numerous disasters and accidents all of which have served to emphasize the inflammability of hydrogen and the risks run whenever this explosive medium is exposed to spark, flame, or heat at an igniting temperature. The magnitude of the peril to which the officers and crew were exposed in the case of the ZR-2 can be more fully grasped when it is recalled that her buoyant gas capacity was 2,700,000 cubic feet—a volume sufficient to lift a total load of 83 tons! It requires no stretch of the imagination to comprehend the tremendous wracking force and the intense heat developed when this gas was set off.

WHILE THE story of helium may be fittingly classed as one of the romances of science, still the commercial production of this gas in the United States can be called nothing less than a magnificent achievement on the part of America's chemical engineers and their associates.

Helium we must have in the fullest practicable measure so as to rob the balloon and the dirigible of one of their greatest perils and, besides, to make it possible the while to construct more efficient airships both for peacetime transportation and for the national defense.

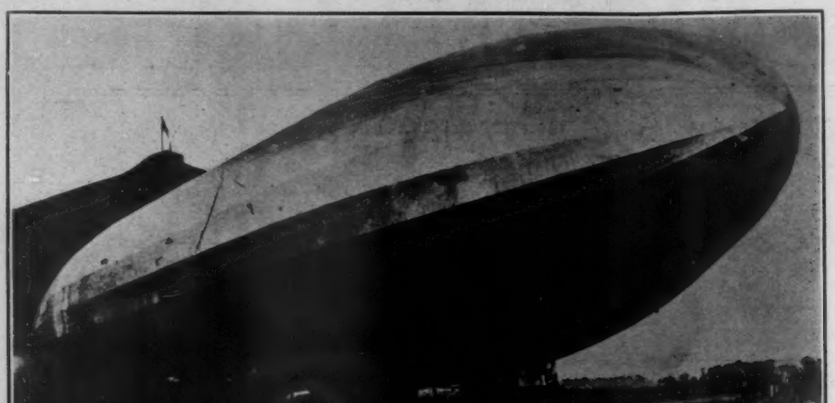
It seems that quite 1,000,000 cubic feet of helium is wasted every 24 hours in this country; and by the installing of proper collecting facilities it would be feasible to obtain here daily anywhere from 5,000,000 to 6,000,000 cubic feet of this extremely valuable gas. Surely we can no longer afford to neglect the opportunity which nature offers us.

Already, in garnering helium from natural gas, the compressor has been of primary service; and in the days to come this machine will probably do a fuller share in a line of human endeavor which is fraught with tremendous potentialities.

It may not be a matter of general knowledge, but it was authoritatively reported when the R-34 made her memorable voyage to America and back to England that her intricate duralumin framework constituted the "ground" of her electric equipment. Therefore, every precaution was taken to insure the metallic continuity of this maze so that there would be no gap anywhere which would occasion a broken circuit and the inevitable sparking. The ZR-2 was lighted electrically, had an extensive telephone system, and had various other electrical circuits essential to her proper operation. If, as in the case of the R-34, the framing of the ZR-2 was likewise a "ground" for her electric systems, then the snapping of a rivet, the fracture of an angle bar, or any kindred structural failure would have led to more or less serious sparking. Accordingly, it is not hard to explain the secondary cause which gave to the disaster its grimmest phase.

Hydrogen gas was used in the ZR-2 instead of the buoyant and non-inflammable helium which because of its non-inflammability robs certain departments of aviation of one of their worst hazards. This brings us to the question: What is our Government doing to foster the output of helium and its employment instead of hydrogen in our naval and military lighter-than-air aircraft? Before answering this question, which vitally concerns the future of aviation generally and national defense particularly, let us look back a bit.

Prior to April, 1918, helium was scarcely more than a laboratory curiosity because so little of it had been obtained, and that only by



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ZR-2 leaving the hangar.

scientifically disposed investigators. We are told that the total quantity separated in the whole world did not exceed, in all probability, more than 100 cubic feet—the cost of production ranging from $1,700 to $2,000 per cubic foot. Although helium is widely distributed in nature, still the amount of it in the earth's atmosphere is in the proportion of only one part in 185,000 parts, by volume, of air; and its availability as a substitute for hydrogen in aviation would, in all likelihood, even now be remote but for the activities of the Bureau of Mines and the contributory labors of many patriotic technical experts during the crucial period of the recent conflict.

Helium, next to hydrogen, is the lightest of known substances, and is one of a series of rare, inert gases—the others being neon, argon, krypton, and xenon. While helium is twice as heavy as hydrogen it has a buoyant or ascensional power, when compared with the latter, of 92.6 per cent. This seeming paradox is explained by the fact that the buoyancy of a gas is measured not directly by its weight but by the difference between its specific gravity and that of the volume of air displaced by it when filling a balloon or the gas bag of a dirigible. In short, either hydrogen or helium is so light, judged by the weight of the air, that the variation in their lifting powers is relatively speaking rather insignificant. Perhaps this can be made somewhat plainer.

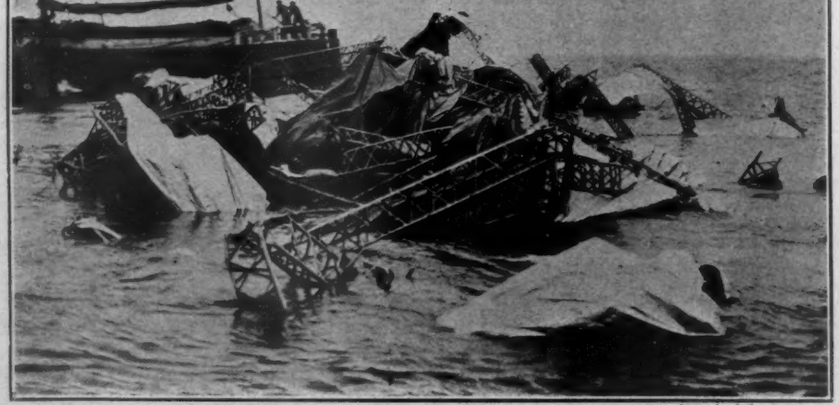
One thousand cubic feet of pure hydrogen will raise from the ground a load of 75.14 pounds: a corresponding volume of pure helium will lift 69.58 pounds. Further, a mixture, composed of 85 per cent. helium and fifteen per cent. hydrogen is capable of elevating a burden of 70.18 pounds. This combination of gases, because of the repressive or inert character of helium, is non-inflammable and admirably suited for use in aircraft. We can easily understand, therefore, the interest aroused among the Entente Allies when it was confidentially announced in 1917 that the U. S. Government was taking steps looking to the early production of helium in large quantities and on a commercial scale which would permit this at a cost previously deemed out of the question. There was every reason to wish America success in this epoch-making undertaking.

We are all familiar with the work done by Germany before 1914 which led to the development of their giant dirigibles or Zeppelins which, as ultimately evolved, had gas capacities ranging from 1,000,000 to 2,500,000 cubic feet of hydrogen and were able to make long journeys at speeds of from 50 to 75 miles an hour. In the early stages of the World War the Germans employed these aircraft extensively for bombing service; and they especially singled out London and the munition districts of England for attack. The damage done to her arch enemy in this way was far graver than the public was given to understand at the time. These airships also proved of immense value as aerial scouts for the German fleet; and by their aid the Teutons were able to keep in touch with the British squadrons and to elect to engage them or to retire to the naval bases. It is a matter of record that a dirigible soared undisturbed high above the Grand Fleet at the Battle of Jutland and made it possible for Admiral von Scheer, despite conditions of low visibility, to bring his guns to bear with disastrous effect upon Admiral Jellicoe's armored ships.

In the course of time both the Germans and their enemies realized that the Zeppelins were extremely vulnerable to a well-organzied attack; and all on account of the very inflammable nature of the hydrogen used to hold the dirigibles aloft. A single incendiary bullet reaching any of the gas bags sufficed to send the huge craft quickly down to earth by transforming her into a flaming mass. It was for this reason that the Zeppelins, for their own security, eventually made their bombing raids only during the hours of darkness.

Recognizing the handicap that hydrogen placed upon the otherwise efficient dirigibles, the desire was to obtain a non-inflammable gas possessing sufficient lifting force which could be utilized instead. Helium was the only known gas which had the required qualities; and early in 1915 Sir William Ramsay reported that he had sought unsuccessfully for the gas in the coal-damp withdrawn by ventilating blowers from British mines. At that date, Dr. Richard B. Moore, of the U. S. Bureau of Mines, had heard directly from Sir William of his quest; but because of our attitude of neutrality Doctor Moore deemed it wisest not to disclose the fact that certain investigators here had ascertained that the natural gas wells of Kansas were capable of yielding helium in large quantities. The existence of helium in the natural gas of that region had been discovered back in 1907, when two of our experts were called upon to find out why the gas burned badly. Analyses revealed the presence of more than one per cent. of helium.

Helium, for aviation, has further virtues than those already mentioned. Experience has shown that this gas diffuses through a fabric at only about 75 per cent. of the rate of the similar action of hydrogen. That is to say, in any interval of time, helium would be slower in working its way outward and escaping into the enveloping atmosphere. Because helium is inert no risk would be run in placing the driving motors of a dirigible within the hull framework. This disposition of the engines,



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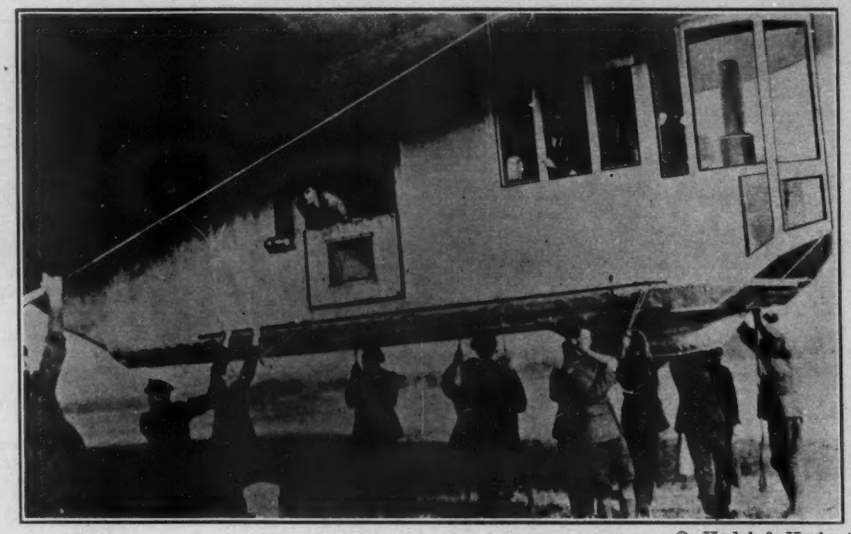
A striking photograph of the wreck of the ZR-2 as it appeared in the river Humber at Hull.

which is prohibited when the buoyant medium is hydrogen, would obviate the present practice of mounting the propelling equipment in underslung gondolas and would allow, instead, the motors to be installed where the thrust of the screws would be nearer, if not in line with, the longitudinal axis of the aircraft, thus making it possible to use the propulsive effort more effectually and to obtain higher speeds for a given horse-power. As it is, the engines are suspended off-center, so to speak, and, therefore, function in a measure like a motorcycle with the lateral drag of an attached side car.

On July 31, 1917, the Aircraft Production Board recommended the allotment of $100,000 to initiate steps which would make helium available as a substitute for hydrogen for balloons and dirigibles. At that time it was not considered practicable to secure helium by any of the generally recognized gas liquefaction and separation processes for less than $80 a thousand cubic feet. As hundreds of millions of cubic feet would probably be needed, it was manifest that means would have to be devised to furnish the gas at a much lower price. While historically it would be interesting to recount all that was done by the U. S. Bureau of Mines under the general direction of Doctor Moore, and how, step by step, various problems were solved and obstacles surmounted, we must here confine ourselves to a brief outline of the procedure adopted to meet an emergency.

Broadly stated, three experimental helium plants—for purposes of secrecy as a war measure known as "argon" plants—were erected at Petrolia and at Fort Worth, Texas, and $500,000 was shortly set aside to cover the outlays involved. The two establishments at Fort Worth were designated Plant No. 1 and Plant No. 2, and relied, respectively, upon the Linde and the Claude processes, widely employed commercially in the treatment of gases; and Plant No. 3, located at Petrolia, was arranged to operate by the Jefferies-Norton process, which was characterized by a number of novel and ingenious departures in the art. In all three of the factories, compressors figured conspicuously at divers stages in the handling of the natural gas and the ultimate production of helium.

The Linde process relies in the main upon the so-called Joule-Thomson effect, which is obtained by the sudden expansion of a highly-compressed gas issuing from a small nozzle, thus inducing the cooling of the gas. This procedure is elaborated into a self-intensive or cumulative cycle of refrigeration by causing the chilled gas, on escaping, to circulate around the tube leading the gas initially into the apparatus. The Claude process, invented by Georges Claude, of Paris, is based upon a liquefaction cycle in which is interposed an expansion engine. While the Joule-Thomson effect is used, its value is minimized because the compression of the gas in this system is somewhat lowered. The maximum cooling is brought about through the agency of the expansion engine inasmuch as the compressed gas, on expanding in the cylinder, is made to do work, and so the desired temperature drop is realized.



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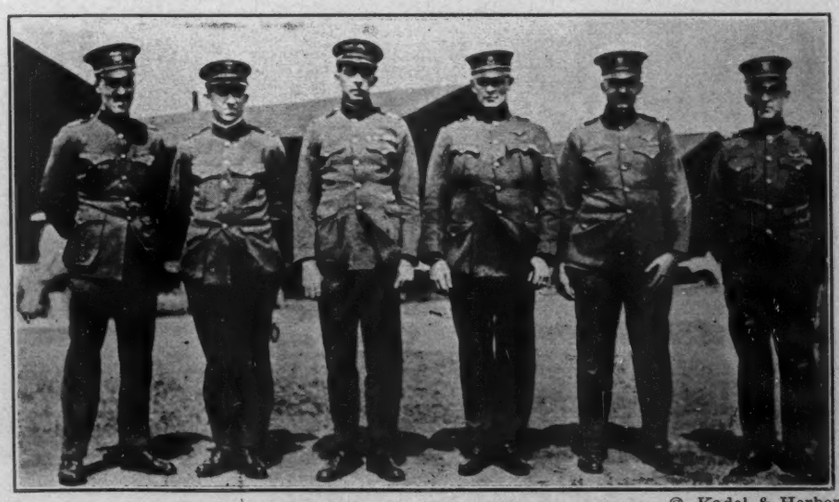
The ZR-2 before starting on its first trial trip prior to its flight to America.

By the Jefferies-Norton process three expansion engines are employed in each unit, the liquid is throttled, and the heat interchanger or refrigerating coil and fractionating still are of new design. The Linde system calls for an enormous expenditure of power for the purpose of first compressing the gas in order to get the maximum effect of throttling, and most of this energy is afterwards wasted. While the Claude process requires, as already explained, much less compression power, nevertheless the energy stored in the compressed gas is largely dissipated before the cycle is completed. The Jefferies-Norton procedure involves only moderate compression of the gas; and even the power primarily needed for this service is conserved and reapplied in driving compressors through the energy developed by the multiple-expansion engines. In short, the maximum chilling action is promoted at a minimum of cost; and Plant No. 3 stands today as a distinctive monument to American genius in an art that is bound to play a big part in our industrial life henceforth.

Before closing the story of our wartime efforts to produce helium in large quantities let us briefly cover the performances of the several establishments created for that purpose. The speed with which results were realized is strikingly typical of native resourcefulness and initiative. Plant No. 1 was the first to start, the date being March 6, 1918, and the actual output of helium began about a month later, when 27 per cent. gas was obtained. Matters improved progressively until a purity of about 70 per cent. on straight runs was reached. By reprocessing, the purity was increased to 92.5 per cent. Things began to move at Plant No. 2 on May 1, 1918, and within twelve days it was turning out gas ranging from 62 to 70 per cent. purity. This product was reprocessed at Plant No. 1 to bring it up to 92.5 per cent. helium. The gas was stored in steel cylinders at a pressure of 2,000 pounds per square inch, each flask containing about 200 cubic feet when expanded to atmospheric pressure. At the time of the armistice 147,000 cubic feet of helium, averaging 93 per cent. pure, was on the dock ready for shipment to Europe. This gas had been garnered during



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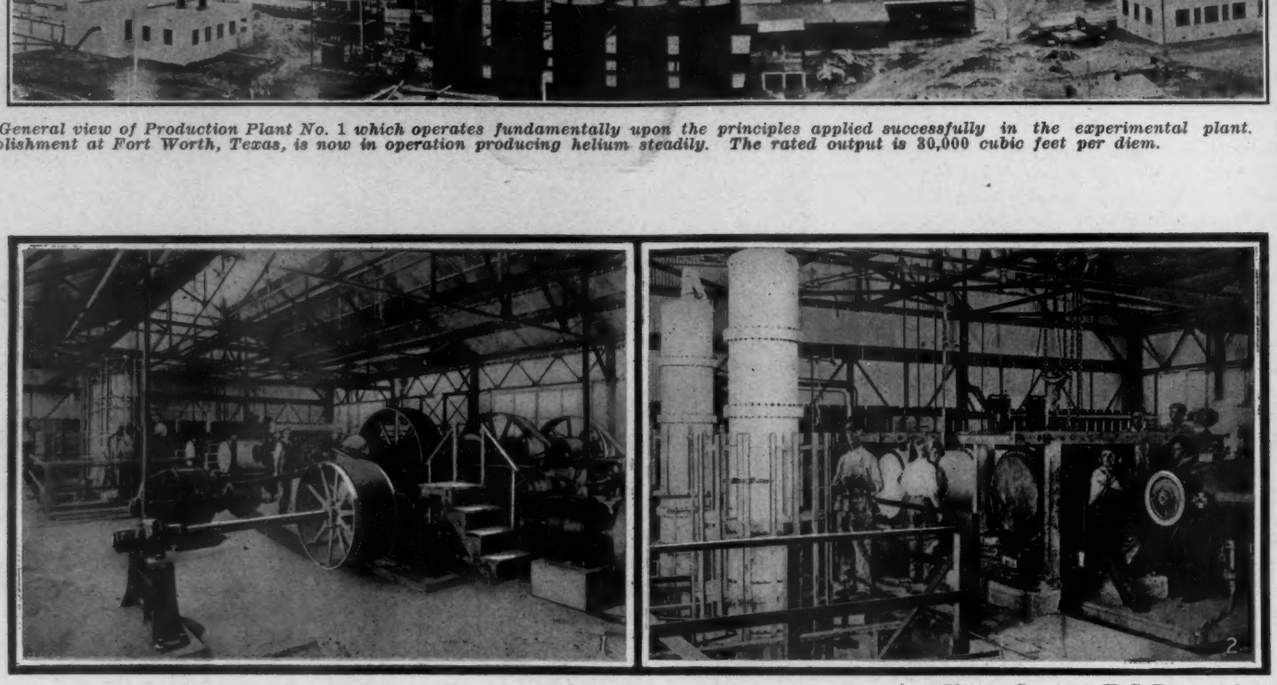
Commander L. H. Maxfield and staff of ZR-2.

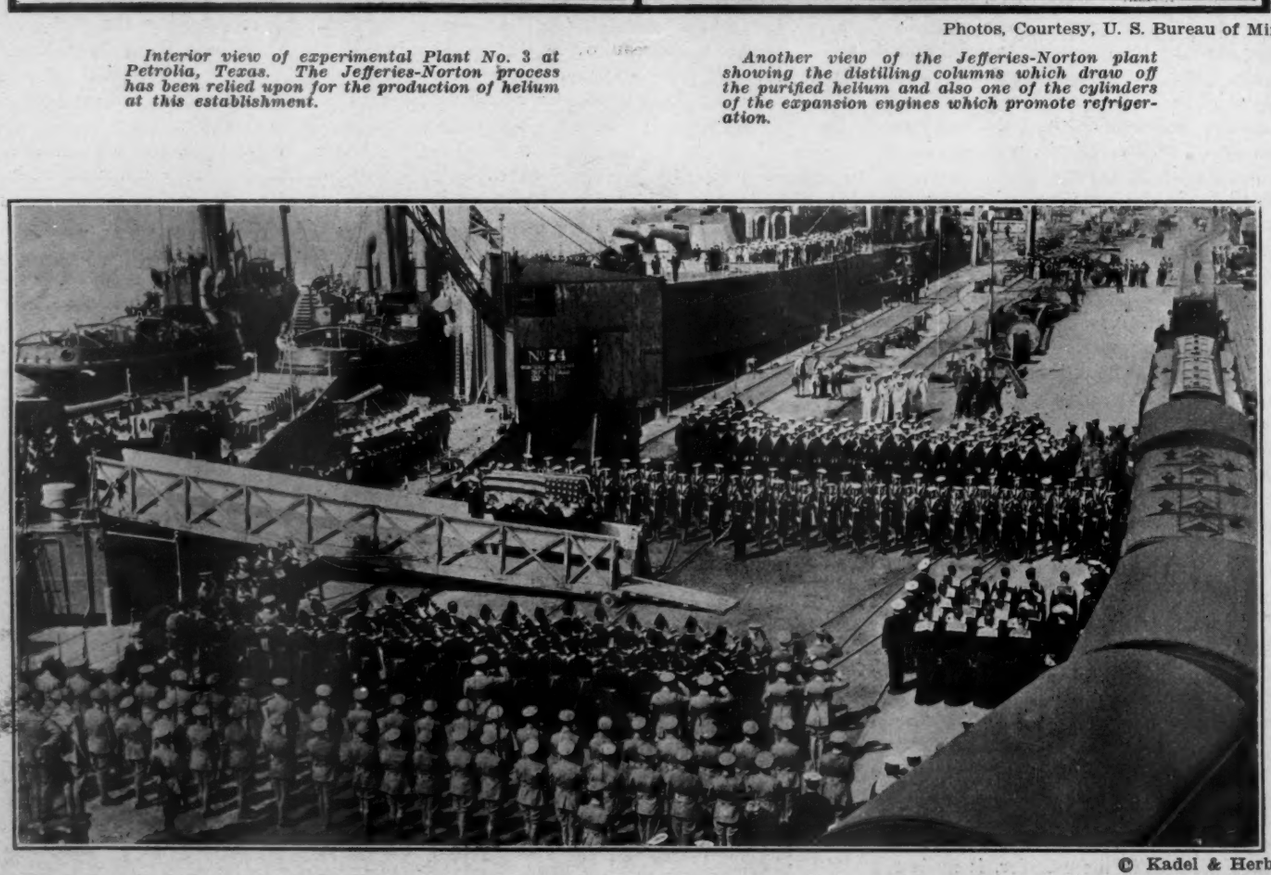
General view of Production Plant No. 1 which operates fundamentally upon the principles applied successfully in the experimental plant. This establishment at Fort Worth, Texas, is now in operation producing helium steadily. The rated output is 30,000 cubic feet per diem.



Photos, Courtesy, U. S. Bureau of Mines.

Interior view of experimental Plant No. 3 at Petrolia, Texas. The Jefferies-Norton process has been relied upon for the production of helium at this establishment.

Another view of the Jefferies-Norton plant showing the distilling columns which draw off the purified helium and also one of the cylinders of the expansion engines which promote refrigeration.



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The scene at Plymouth when the coffins containing the bodies of the American victims of the ZR-2 were transferred from the train to the cruiser "Dauntless" for conveyance to America.

the experimental stages of the undertaking. Altogether, about 200,000 cubic feet of helium was produced by Plants Nos. 1 and 2 before they were ordered to be shut down on January 23, 1919.

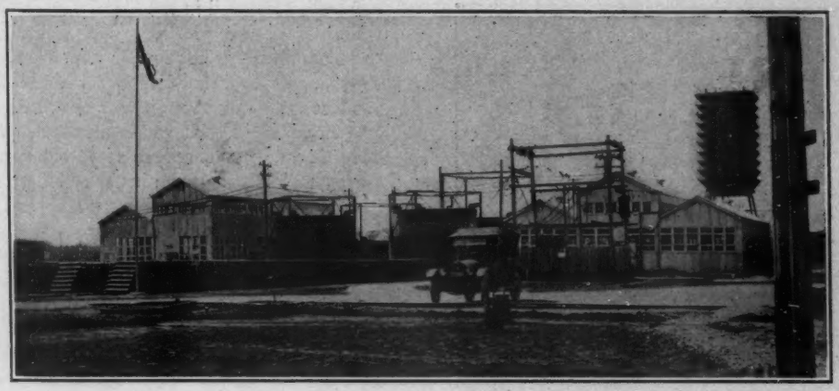
The performance of Plant No. 3, measured by material results, was not so impressive as that of the other factories, but this was to be expected in view of the novelty of the process followed there. Doctor Moore tells us: "Plant No. 3 at Petrolia had many obstacles to overcome. Its location was poor from a transportation point of view, but it was thought that its location, close to the Lone Star Gas Company compressor plant, would have many advantages. For experimental purposes, it was decided that it would not be necessary for Plant No. 3 to have its own complete compressor outfit, as it could get the gas from the Lone Star Compressor Station at from 225 to 250 pounds, and could then boost it with one compressor up to the operating pressure of 300 pounds. This arrangement eliminated a considerable amount of equipment at the start, and enabled the plant to get into operation a little earlier.

"On the other hand, the apparent gains by this system were more than offset by difficulties which were not anticipated. Notwithstanding these and other difficulties, a run was obtained on April 2, 1919, during which helium of a grade of 19.8 per cent. was produced. On April 17, helium of 21 per cent. was made, but the plant has not been able to produce helium regularly and consistently, the above results being obtained on specially favorable runs.

"The Jefferies-Norton process was given an extremely difficult undertaking right at the start in applying it to the extraction of helium from natural gas where there was less than one per cent. of the material to be extracted in the product used. In addition, there was no intermediate experimental work done between a small laboratory equipment and the installation of Plant No. 3, which is probably the largest single refrigeration unit in the world. Under these circumstances the performance of the plant was quite remarkable. Since the time mentioned a number of changes have been made in the plant, with the object of improving its operating efficiency. During the fall of 1920, some radical changes were made in the whole design of the plant."

It has been estimated that the actual cost of producing helium at Plant No. 1, as late as September, 1918, was $146 a thousand cubic feet for 70 per cent. gas. Of that amount, $53.40 went towards the purchase of nitrogen for the "make-up" on the external nitrogen cycle. Therefore, the price could have been reduced to $92.60 had the plant been capable of providing its own nitrogen. It is expected that by the Jefferies-Norton process it will be practicable to obtain helium at $20 a thousand cubic feet, figured on a basis of 100 per cent. pure.

Up to and including most of October, 1918, there had been allotted for the manufacture of helium at the three plants described funds totaling $1,090,000. The outlay, besides adding vastly to human knowledge, supplied a commodity worth, at pre-war prices, anywhere from $250,000,000 to $400,000,000, and yielded a war weapon of incalculable value to the United States.



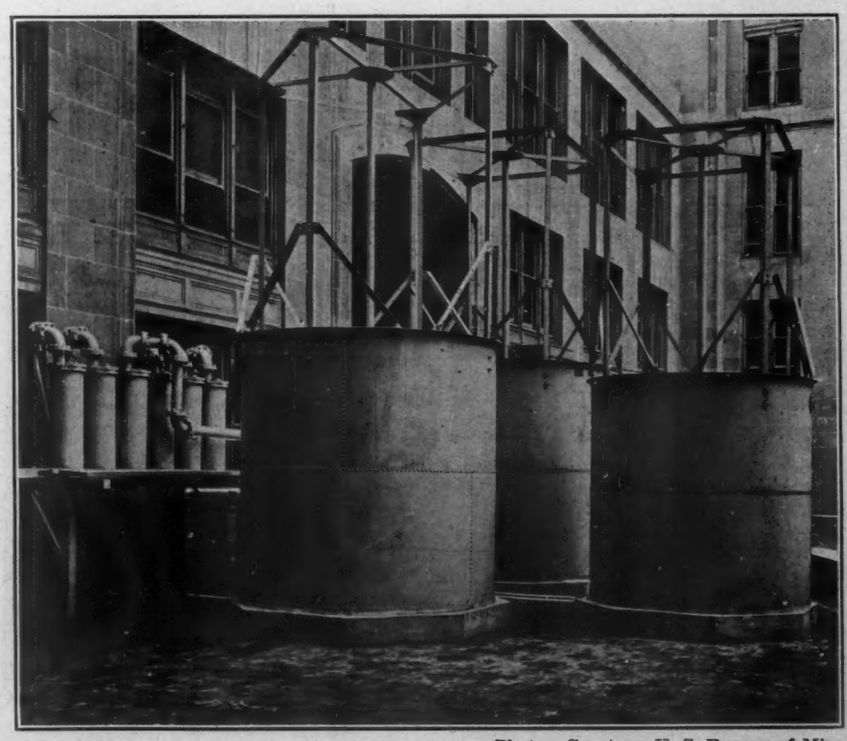
Experimental Plant No. 1 at Fort Worth, Texas, where the Linde process was adapted to the production of helium from natural gas derived from the Petrolia field.

Following the cessation of hostilities, and profiting by the experience gained at the other establishments, there has been erected by the Government at Fort Worth, Texas, what is officially designated as Production Plant No. 1. This station represents an expenditure of about $2,000,000 for buildings and equipment, and has been operating steadily for months in producing helium by a modified Linde process. The rated capacity of the plant is 30,000 cubic feet of helium per diem.

As a further step in the prosecution of this fascinating element, and to secure much scientific data that is still needed in order to insure the proper and efficient working of helium plants, the U. S. Bureau of Mines has recently created in Washington a cryogenic laboratory with Doctor Moore in charge. It may also be said that another reason for the existence of the cryogenic laboratory is to perfect processes and apparatus by which helium, after it has been used in a dirigible, can be repurified, i. e., freed from atmospheric admixtures, and thus made fit again for aviation.

Indeed, it seems that the army already has a mobile repurification unit which is installed upon a couple of railroad cars. One car carries the power plant for generating the necessary current, while the other has aboard the compressors and the essential refrigeration apparatus for repurification of helium, withdrawn from balloons and dirigibles, after the purity has dropped below the minimum of efficiency. A charcoal-repurification unit has been designed by the Bureau of Mines as an auxiliary to this outfit. And now for a brief description of the cryogenic laboratory at Washington.

The installation in the Department of In-



Photos, Courtesy, U. S. Bureau of Mines.

Air purifiers and storage tanks for hydrogen for helium at the cryogenic laboratory.

Doctor Richard B. Moore, who had general supervision of the experimental helium plants during the war and who is now in charge of the recently instituted cryogenic laboratory in Washington.

terior Building consists of two four-stage air compressors, rated at 75 cubic feet of free air per minute, each, compressed to 3,500 pounds per square inch at 135 revolutions per minute. These compressors are driven by two 50-horsepower variable-speed, 220-volt direct-current motors. The purpose of these compressors is to aid in making liquid air and to provide refrigeration for other purposes. Air to the measure of from fifteen to twenty liters can be liquefied hourly. In addition, there is a three-stage compressor of the vertical submarine type with a capacity of about 29 cubic feet of free air per minute. This machine is for service in connection with the liquid hydrogen cycle, and compresses the gas to 3,000 pounds per square inch. It is actuated by a fifteen-horse-power, variable-speed, 220-volt direct-current motor. Another three-stage submarine type of compressor, rated at sixteen cubic feet of free gas per minute, is provided for work in the liquid helium cycle. All of the compressors have unloading valves so that their capacities can be varied within rather wide limits.

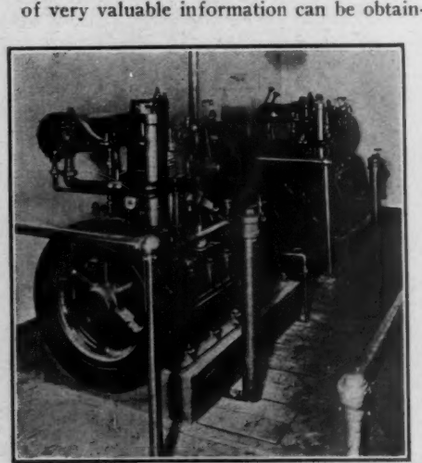
The laboratory has, besides the apparatus mentioned, two 300-cubic foot and one 200-cubic foot gas tanks for the storage of hydrogen and helium; four smaller holders for the retention of gas samples; a suitably equipped machine shop; one air-reduction, low-temperature expansion engine; air and hydrogen liquefiers; and the necessary physical and chemical apparatus appropriate to the proper functioning of the laboratory.

Doctor Moore has kindly supplied the author with the following statement of the immediate problems which are under investigation by the laboratory, and these are classified under three headings, to wit:

"1. The application of charcoal at low temperatures for the purification of helium. When helium is produced in the plants the gas obtained from the first stage of operations contains from 70 to 80 per cent. helium. This has to be refined in order to give a product averaging about 94 per cent. helium. The impurity in each gas is nitrogen. We have found that charcoal at low temperatures will absorb the nitrogen and practically not absorb the helium at all. In addition, we can get 100 per cent. product instead of 94 per cent. This additional grade means decreased cost of operation of a dirigible because it gives a wider range of operation, and also, for the same lifting power, requires a smaller ship. As the helium would have to be refined again when it reaches but 85 per cent., you can see that in one gas, with 100 per cent. helium, there would be a leeway of fifteen per cent., whereas in the other gas, with 94 per cent. grade, there would be a leeway of only six per cent. In addition, we have every reason to believe that the cost of treatment by this method would be cheaper than the one now used, besides giving a higher grade product.

2. There are numerous problems in connection with the operation of the plants, particularly Plant No. 3 using the Jefferies-Norton process, which can be worked out better in the laboratory. I cannot specify all of these problems at the present time because there are a number with which we are probably not fully acquainted. The one we are working on, however, involves the temperatures and pressures at which the constituents of natural gas, such as Petrolia natural gas, are severally liquefied from a complex mixture. It is readily seen that when six or eight constituents are in a gas these are not progressively liquefied in a pure state, and it is important to know the compositions of the liquids and unliquefied gases at various temperatures and pressures. Such knowledge is absolutely necessary for the efficient design and operation of liquefaction plants in connection with helium recovery.

3. We are also after the liquefaction of hydrogen and helium in quantity. A great deal of very valuable information can be obtained from having these liquids at hand, as we can by means of them attain temperatures which have been available only to a very limited number of people in the past. In the case of helium, Professor Onnes, of Leyden, is the only one who has ever liquefied this gas. By having at our disposal these liquids in reasonable quantity, the accumulation of much scientific information of great value will be possible, as very little work has hitherto been done on these low temperatures."



Courtesy, U. S. Bureau of Mines.

Motor-driven compressors for service in connection with the liquefying of hydrogen and of helium.

It may be interesting to note here that liquid helium boils at 4.25 degrees above absolute zero; that it attains its critical temperature at 5.25 degrees above absolute zero; and that by the rapid evaporation of liquid helium a temperature below 2.5 degrees above absolute zero may be achieved.

Through the medium of helium, which we have been foremost in producing, we may not only revolutionize lighter-than-air aviation but we may be able to solve some of nature's riddles. These are likely to prove quite as startling as the revelations which radium has so recently been instrumental in making. In drawing aside the veil of ages with the help of helium, the compressor has been and will probably continue to be man's principal aid.

COMPRESSED AIR IN QUARRIES

Compressed air is being used, near Atlanta, Ga., in quarrying granite, and it has been found to have advantages over the more usual method when the granite rock is devoid of "joints," says *Popular Mechanics Magazine.* Two three-inch holes are drilled, a short distance apart and perpendicularly to the rock, to a depth of eight feet. After removing the drills, a spoonful of black blasting powder is dropped to the bottom of each hole, tamped with clay, and the holes wired so that they can be electrically fired. The effect of the explosion is to start cracks in the rocks at right angles to the holes. This operation is repeated a number of times, until it is certain that the cracks radiate from the bottom of the holes to a distance of about 75 feet. Into each hole, to slightly over half its depth, there is then inserted a one-inch pipe, and the space surrounding pipes in the holes is filled with sand, tamped so as to seal it against air pressure. Connections are then made between the upper ends of the pipes and the quarry air compressor, which continues to pump air, at 100-pound pressure, into the holes until the block of rock above the cleavage already formed is torn from the surrounding rock.

At the Central District Experiment Station at Urbana, Ill., an examination of samples collected in the Pratt coal seam in Alabama shows that the variation of sulphur content is due almost entirely to variations in the amounts of pyritic sulphur; the organic sulphur content remaining constant. The determination of sulphur in raw coal and washed coal collected at the washery of the Woodward Iron Co., Woodward, Ala., confirms previous conclusions that organic sulphur can not be removed by washing and is often higher in the washed coal.

Conveying System for Pulverized Materials

By W. B. NEIDE
Fuller Engineering Co., Allentown, Pa.

IN CONSIDERING methods of transportation of pulverized materials most of us have turned our attention to the screw or belt types of conveyors. Of course, for some time there have been conveyors using small volumes of high pressure compressed air or large volumes of low pressure air. In this latter system the air was usually supplied by a centrifugal fan. However, in most cases the mechanical method predominated.

The above systems presented a rather narrow field from which to choose as each had certain disadvantages. Recently there has been developed a newer system which combines the positive features of the mechanical and air conveyors and eliminates the weak points found in either one. This method was originally developed for use in transporting pulverized coal from the pulverizing mills, to the service bins above the furnaces.

The idea has worked out so well with pulverized coal that the system is now being developed for transportation of other pulverized materials, which, on account of the way they are used, must be practically dry before being carried from the pulverizing stations to the points of consumption.

This new system is known as the Fuller-Kinyon Conveying System. It combines the mechanical action of the screw conveyor with the fluidizing properties of air, imparting motion to the mass of pulverized material. There are four main elements in this arrangement. First, a helical pump, the function of which is to start the flow of material; second, a source of compressed air supply; third, a pipe through which the material flows; and fourth, diverting valves which allow the flow to be discharged through any number of branch lines into the service bins.

The pump, which is shown in Figure 1, is composed of a worm or screw revolving in a barrel or working chamber. The worm is mounted on an extension shaft which passes through packing glands, located in each end of the casing and supported by outboard bearings. It will be noticed that this arrangement prevents any of the pulverized material from coming into contact with the bearing metal and causing undue friction or ruined bearings.

Pulverized material is fed from its source into the pump hopper and from there it is carried through the barrel to the discharge end by means of the revolving screw. Here the mass is aerated by a stream of low volume compressed air at moderate pressure. This aeration changes the nature of the material from a compact mass to a fluid in which state it is carried through the pipe line to the point of discharge. The compressed air is usually supplied from a reciprocating, single-stage compressor. In this system the manufacturers prefer the air compressed to approximately 70 pounds gage pressure (reserve pressure for blowing out line) and then reduce the pressure to 30 pounds before mixing the air with the pulverized material.

The conveying line is built of ordinary wrought iron pipe, proper provision being made to eliminate recesses in which particles might lodge. The size of pipe depends upon the capacity required. For existing installations the pipe size varies from three inches to five inches in diameter.

Distributing valves, which are located in the pipe line, are of the disc, multiple discharge port type so arranged that the stream of material may be diverted from the main line to two or more branch lines. The action of these valves is positive, preventing a flow past the ports which are in a closed circuit and at the same time allowing an unobstructed passage through the open main.

The action of this conveyor system is clearly shown in Figure 2 which illustration shows the compressor, helical pump, conveyor pipe and storage bins. This system has many advantages over the older methods of transportation. Safety is insured because the volume of injected air is only a small fraction of that required for combustion and in no place in this system is an explosive mixture approached. The small amount of air also eliminates the necessity of discharging material into an air separator at the end of the line. The flexible construction of the system makes it adaptable to any existing or contemplated plant layout.

There is only one moving element, with the exception of the air compressor. Consequently, the system should be very dependable and the upkeep and repair cost reduced to a minimum. The fact that the apparatus is completely enclosed eliminates all dust which is both unhealthy and dirty.

Other advantages claimed by the manufacturer are: less power and labor required to operate than is necessary in other systems; the equipment is not subject to temperature or climatic changes when the conveyor line is exposed to the weather; first cost of installation is less than that required with other systems.

There are numerous installations where the above system has been used for transporting pulverized coal. These are located in steel mills, boiler plants and various cement mills.

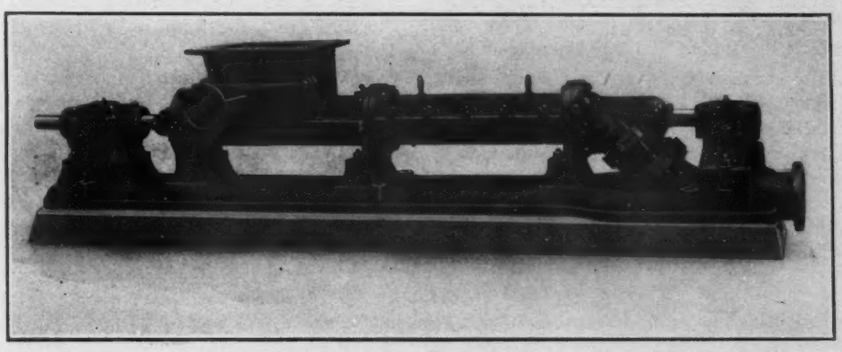


Fig. 1—Six-inch Type C-Fuller-Kinyon pulverized material pump.

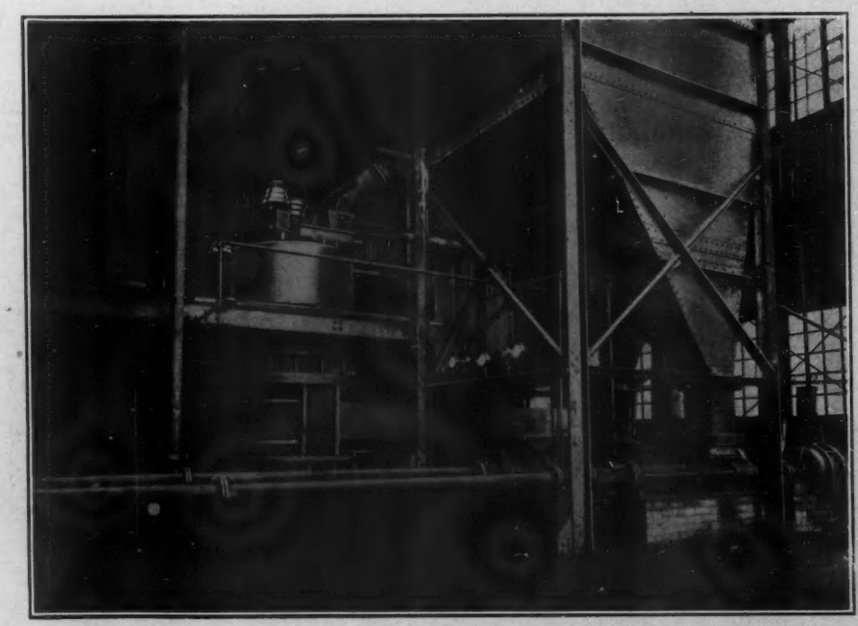


Fig. 2—Conveyor system showing equipment compressor, pump, storage bins, etc.

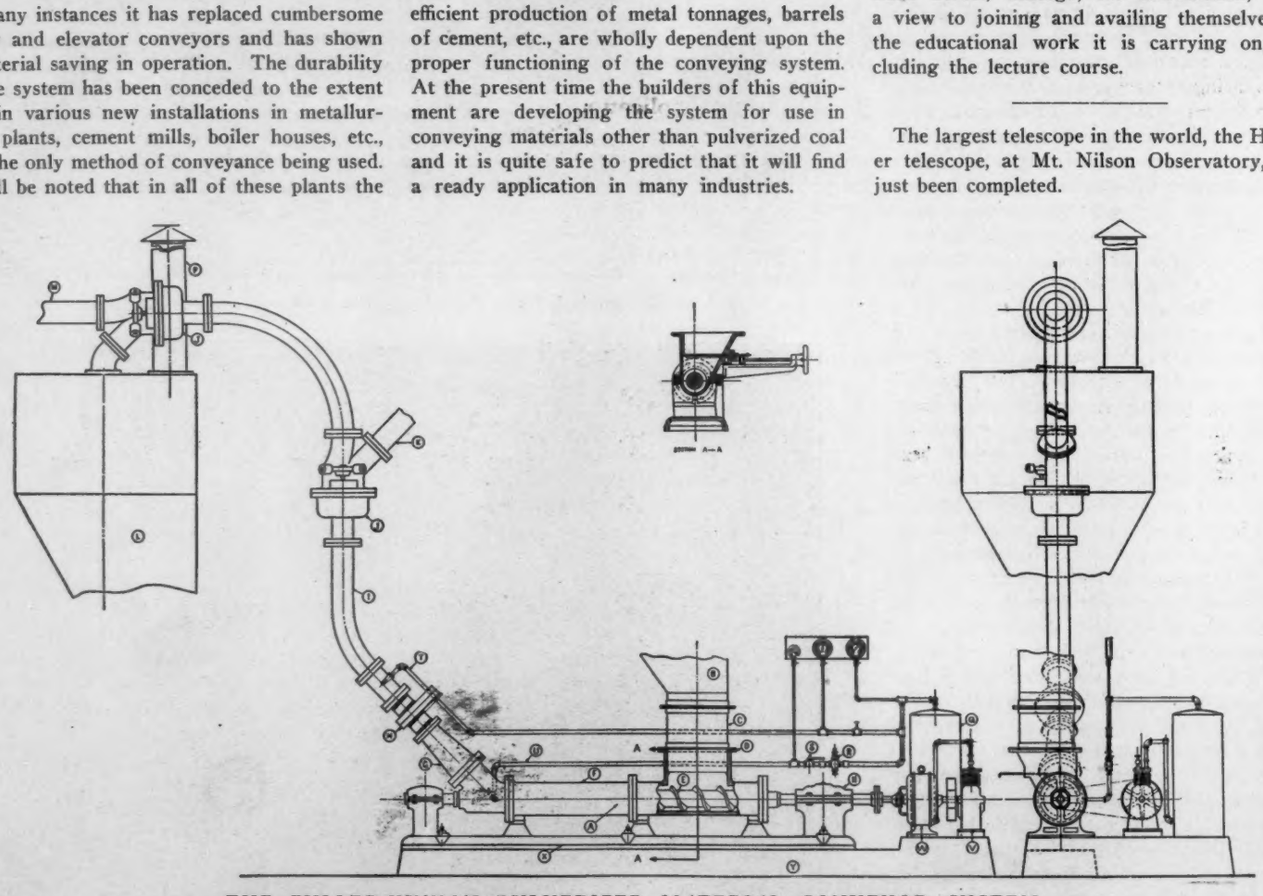
Two 250 H.P. Stirling boilers fired with pulverized coal.

In many instances it has replaced cumbersome screw and elevator conveyors and has shown a material saving in operation. The durability of the system has been conceded to the extent that in various new installations in metallurgical plants, cement mills, boiler houses, etc., it is the only method of conveyance being used. It will be noted that in all of these plants the efficient production of metal tonnages, barrels of cement, etc., are wholly dependent upon the proper functioning of the conveying system. At the present time the builders of this equipment are developing the system for use in conveying materials other than pulverized coal and it is quite safe to predict that it will find a ready application in many industries.

NATIONAL ASSOCIATION OF REFRIGERATING ENGINEERS

THE TWELFTH annual convention of the National Association of Practical Refrigerating Engineers will be held at Hotel Lorraine, Philadelphia, Pa., on November 30, and December 1, 2 and 3, 1921. This is the first meeting of the Association to be held in the East, and it is confidently expected that it will eclipse any previous gathering of refrigerating engineers. The program to be provided will include papers by men of world-wide reputation, who are being chosen because of their familiarity with the particular subjects in which the membership, and refrigerating engineers in general, are interesed. Also there will be papers of interest to all groups of the refrigerating industry, including the employers and managers who will be welcome to attend as visitors. The Educational and Examining Board of the National Association of Practical Refrigerating Engineers has recently had prepared under its supervision a lecture course on "The Principles of Refrigeration," in twenty parts, for the benefit of its members. Starting with Lecture No. 1, the course is sent to them at intervals of two weeks. Refrigerating engineers who are not now members of the Association would do well to write the National Secretary, Mr. Edward H. Fox, 5707 West Lake Street, Chicago, for information, with a view to joining and availing themselves of the educational work it is carrying on, including the lecture course.

The largest telescope in the world, the Hooker telescope, at Mt. Nilson Observatory, has just been completed.



THE FULLER-KINYON PULVERIZED MATERIAL CONVEYOR SYSTEM

"A" Fuller-Kinyon 6" Pulverized Material Pump. "B" Material Bin. "C" Supply Spout. "D" Pump Hopper. "E" Forcing Worm. "F" Pump Barrel. "G" Reducing Nozzle. "H" Single Diverting Valve. "I" Convertor Conduit. "J" Two-way S. K. Valve. "K" Branch Conveyor. "L" Receiving Bin. "M" Continuation of Conveyor. "N" Main Bearing. "P" Vent Stack to Receiving Bin. "Q" Air Receiver. "R" Pressure Reducing Valve. "S" Air Valve. "T" Conduit Clearing Air Line. "U" Aerating Line. "V" Air Compressor. "W" Electric Motor. "X" Pump Base. "Y" Foundation.

Pneumatic Street Tubes In London

A Mechanical Delivery System Carrying Millions of Messages Annually Is in Operation in Several European Capitals Using Pneumatic Power for Propulsion of the Carrier—Reduces the Time in Transit, Relieves Congestion of City Streets and Insures Against Accidental Loss or Theft

By A. B. EASON
(M.A.; A.M. I. E. E.; Assoc. M. Inst. C. E.).

THE PURPOSE of street pneumatic tubes is to convey messages, letters, and parcels from post-offices to other post-offices, newspaper offices, or certain business premises having such a large volume of traffic that it is worth while to rent a tube from the Post-Office Department. The vast majority of tubes are employed for conveying telegraphic traffic; but in Paris the system carries letters and in some systems parcels are transmitted. This article gives some particulars of the system in London, dealing with (1) the tubes; (2) the pumps and machinery for supplying the compressed or rarefied air for working the tubes; (3) the terminal apparatus for inserting and withdrawing the carrier; (4) the traffic carried; (5) the system of tubes in Berlin is described.

The London system is a radial one at the centre of which is the Central Telegraph Office (called C. T. O.) from which 55 tubes radiate. The number and size of tubes and the method of working each one, viz.: "Up," "Down," or "Bothway," is shown diagrammatically in accompanying illustration and in tabulated form herewith.

Summary of London Tubes

Method of Working	Diameter of Tubes	
	2¼ in.	3 in.
Down	7	3
Down with intermediate office	5	1
Up	12	3
Up with intermediate office	8	2
Bothway	14	nil
Total	46 plus	9 = 55

Two additional tubes, one "Up" and one "Down" are being laid.

"Down" tubes carry traffic from the C. T. O. to out offices; "Up" tubes carry traffic to the C. T. O. "Bothway" tubes carry traffic as required in either direction.

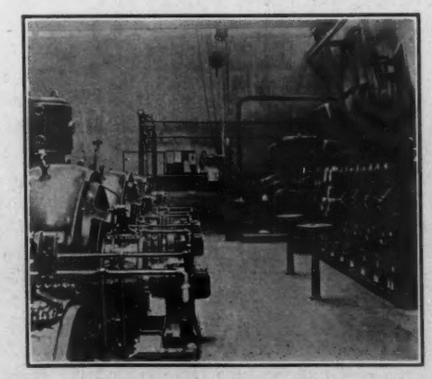
The quantity of air used per 2½-in. tube varies from 4 to 6 lb. per minute, or 50 to 75 cu. ft. free air compressed to 10 lb. pressure depending upon the length, if the tubes are worked continuously; and from 5 to 7 lb. per minute if the tubes are worked intermittently. The power is kept on continuously in the one case; in the other case power is turned on when a carrier is to be sent and is turned off when the carrier is received. Then there is a period of time during which power is not on the tube at all, the duration of this period depending upon the amount of traffic being carried. During busy hours on tubes worked "Bothway" carriers are sent alternately "Up" and "Down;" and there is very little idle time. As soon as one carrier is received, another is sent away with the messages which have been received while waiting for the incoming carrier. Tubes worked in one direction only may be operated intermittently, but if the traffic is small enough to justify intermittent working, it is probable that the tube could carry the traffic in the reverse direction during the idle periods and the tube would then be a "Bothway" tube.

THE USE of the pneumatic tube as a carrier for parcels, letters, newspapers and other similar objects of varying weights and sizes and in large volumes which must be delivered expeditiously to all parts of our large cities presents a big field for the mechanical specialist.

The distribution of these packages is usually performed at the present time by motor or horse drawn vehicles and by human agencies that greatly aggravate the congested conditions from which these centers of population are now suffering.

The pneumatic tube carrier in the future will extend its mechanical application to a much wider area that will eliminate the disadvantages of the present system and relieve the arteries of travel in the metropolitan districts of an extra and useless burden.

In "Down" tubes worked intermittently with



Switchboard and air compressors in General Post-office basement.

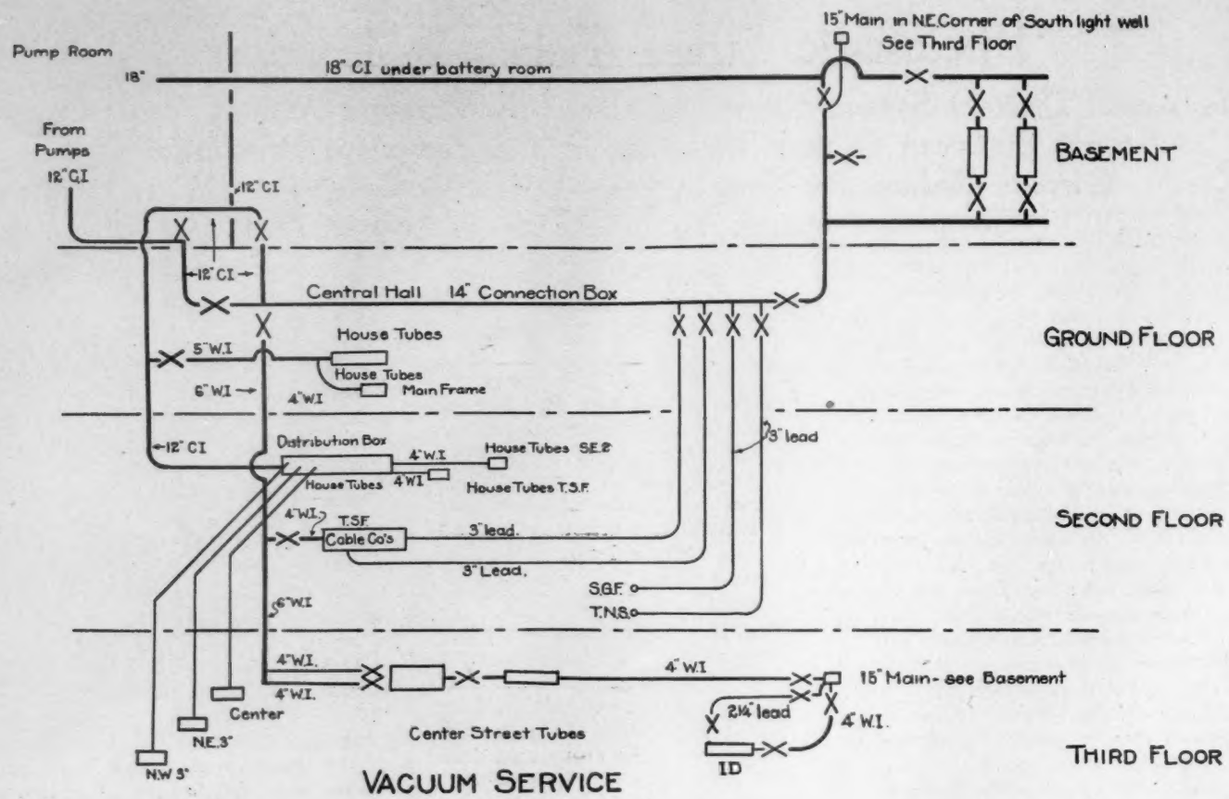
pressure the amount of air used per minute is considerably greater than if the tube were worked continuously; if the idle period in an hour is small then the total amount of air used per hour becomes greater with intermittent working than with continuous working. The average delay experienced by a message is greater in tubes worked intermittently than in continuously worked tubes because carriers cannot be despatched so frequently. The carrier in the tube must reach its destination before another carrier is inserted, in order that the signaling of despatch and receipt of carriers may be kept right. When tubes are worked continuously carriers may be inserted at intervals of 30 seconds or so depending upon the time carriers take to traverse the tube.

The amount of air used by a tube depends on the length and diameter of the tube and on the pressure of air in the tube at the point immediately after the cock which controls the tube; it does not primarily depend upon the pressure at which the air is delivered by the pumps. That is to say, the cocks upon the service pipes leading to the tube may throttle the pressure considerably and only the pressure at the sending end for pressure tubes and at the receiving end for vacuum tubes—the pressure at the other end being atmospheric—is of primary importance. It is the one factor which is readily variable. The dimensions of a tube *in situ* are practically invariable. If the speed of carriers in a tube is to be altered, then the pressure of working at one or both ends of the tube must be altered.

Machinery for Supplying Air Under Pressure

The pumping plant at the C. T. O. is situated in the basement of the General Post Office; the upper floors contain the telegraph office. There are four high speed single stage air compressors (see illustration), each with two cylinders 30½-in. diameter, 14-inch. stroke, having a displacement of 4,000 cu. ft. at 170 revolutions per minute. Each compressor is driven by a 240 h.p. electric motor the speed of which can be varied between 150 and 200 revolutions per minute. After-coolers are fitted by the pumps. Regulating valves are fitted on each compressor so that if the pressure in the reservoirs exceeds 10 lb. per square inch, the compressor delivery is opened to atmosphere and it runs unloaded on the pressure side.

The compressors are each joined to 12-in. ring mains. One main comes from the vacuum reservoirs; one main goes to the pressure reservoirs and one main is at atmospheric pres-



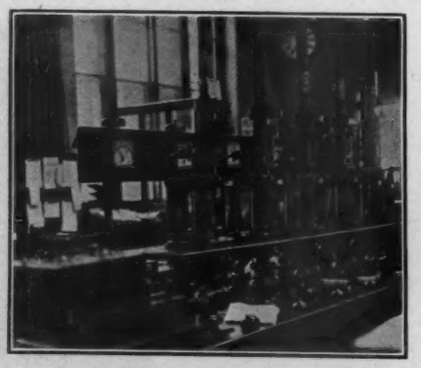
VACUUM SERVICE

sure. Valves are installed so that any of the compressors can suck air from vacuum or atmosphere, and can deliver to atmosphere or to the pressure main.

There is also a low vacuum main joined to the system of house tubes in the C. T. O. (see COMPRESSED AIR MAGAZINE, Vol. 25, June, 1920; pg. 9673) which can be joined to the inlet pipe of one compressor.

The vacuum maintained in the reservoirs for working the street tubes is about 6½ lb. per square inch; and the pressure in the pressure reservoirs varies between 10 lb. per square inch, at which point the compressors cut out and 7 lb. per square inch at which point they cut in. The reservoirs consist of disused Lancashire boilers, 21 ft. long, 6 ft. 6 in. in diameter, there being four for pressure and two for vacuum.

The street tubes are taken to various floors in the C. T. O., the floor chosen depending upon the destination of the majority of the messages received from the tube. Thirty-two tubes terminate in the Central Hall on the ground floor, along what is termed the Main Frame; ten tubes terminate on the second floor where most of the foreign telegraph wires terminate; six tubes terminate on the third floor at centre on a table on which are the house tubes; six others also terminate at centre at another table; one tube terminates in the news division on the third floor. It is likely that additional tubes to newspapers will be installed there at some future date.



Street tubes at center, 3rd floor.

The distribution of air from the pumps to the reservoirs and from there to the tubes is shown in one of the illustrations. At the above-mentioned points are connection boxes in which are placed 2¼-in. and 3-in. cocks, some of these being full bore. Some years ago all the cocks were 1¼-in. and serious throttling occurred between the connection box and the tube. Considerable improvement in the working of the tubes was made by introducing the full bore cocks on the longest tubes.

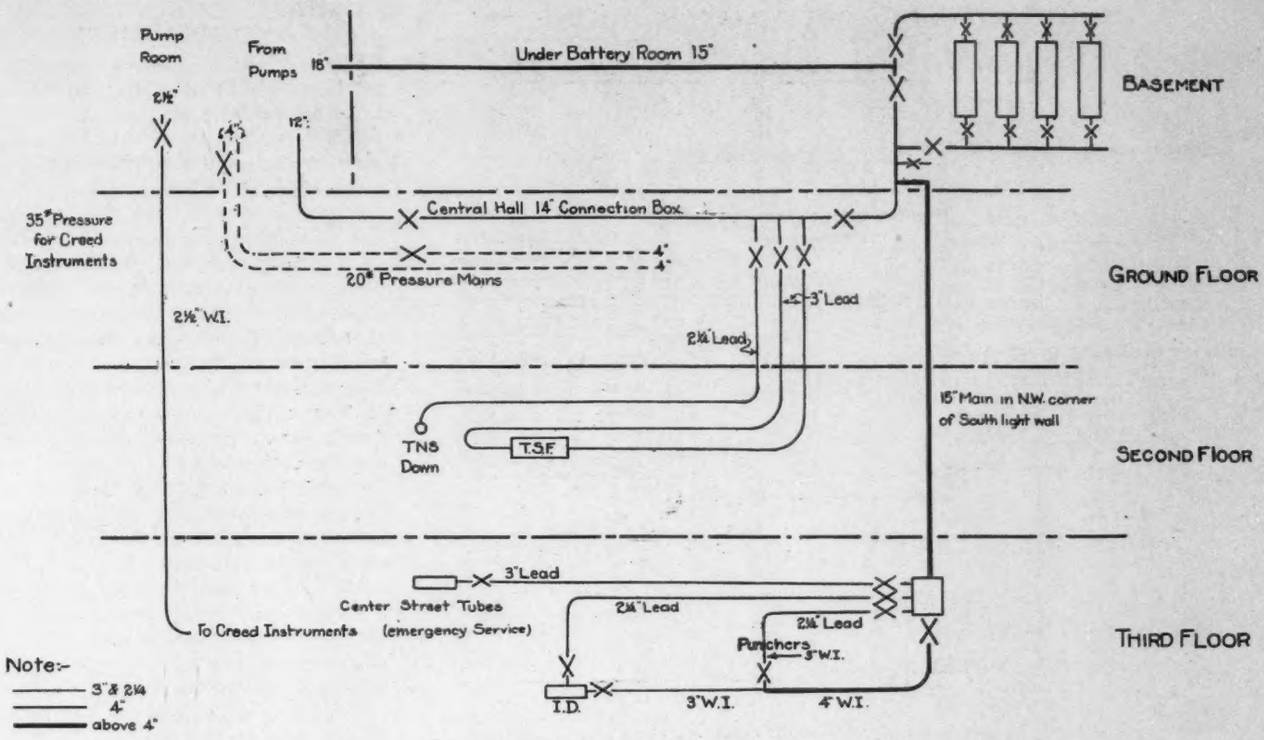
Since the tubes are of various lengths, it is necessary to throttle down the air supply to the shorter ones to avoid waste of air. The time taken by a carrier to reach its destination in the case of the shortest tubes even with the pressure throttled is only 30 seconds or so From the cocks, lead service pipes lead to the controlling cocks, which can be manipulated by the tube attendants between the shelf on which the switches rest and the shelf on which are the press buttons for signaling. The illustration shows some of the lead service pipes leading from the cocks on the connection boxes to the cocks at the tube table behind the Main Frame in Central Hall.

Terminal Apparatus for Tubes

The switch, by means of which carriers are introduced into and withdrawn from the tube, may be described in detail. It is called a double slide switch, its chief feature being that carriers can be removed and inserted in the tube without the power being interrupted. The apparatus used prior to 1912 and still in use in some towns consisted of a receptacle in which a door had to be opened to withdraw a carrier; the power on the tube had to be cut off in order to open the door. The cessation of power caused a slow motion of the air in the tube and the opening of the door and manipulation of the cocks took a considerable time. The apparatus in use at Berlin is manipulated still on these old fashioned lines. The new double slide switches reduced the handling time considerably.

The switch has two tubes fixed in a frame movable between the top and bottom plates. One of the tubes is kept in line with the street tube and the other is in line with an opening

Street tubes along the main frame in Central Hall.



PRESSURE SERVICE

for receiving the carrier if the tube is to be loaded with a carrier, or in line with an opening through which the carrier may fall out if the tube is to be unloaded. The switches at the incoming ends of tubes worked "Up" have openings only in both sides of the bottom plate so that carriers fall out with the switch in either the right hand or left hand position. The top plates of switches on "Down" tubes have openings similarly on both the right and left hand sides. Switches on tubes worked "Bothways" have one aperture open in the top plate and the opposite one open in the bottom plate.

These switches will hold only one carrier. If two carriers arrive together the switch cannot be moved horizontally, as the second carrier rests partly in the fixed portion of the street tube and partly in the movable portion. In that case the door of an "emergency" chamber fixed above the switch is opened, and the second carrier is abstracted. The vacuum has first to be cut off. Sluice valves are provided above the chambers so that the vacuum in the street tube may be cut off if desired, and the control cock can be manipulated to cut off the vacuum below the switch. These emergency chambers are fitted only on "Up" tubes.

At the end of the tubes in out-offices where the pressure is atmospheric a simple wooden box is placed. Carriers drop into this in case of "Down" tubes or are inserted in the open end of the tube in case of "Up" tubes.

In the Central Hall the "Up" tubes are grouped at the right hand side, and a band carrier is placed under the shelf carrying the switches, so that as the carriers fall out they are carried to the one end of the frame and an attendant abstracts the messages. The only work the switch attendants have to do is to move the switches from side to side when carriers arrive and to signal the receipt of carriers to the sending offices.

Traffic

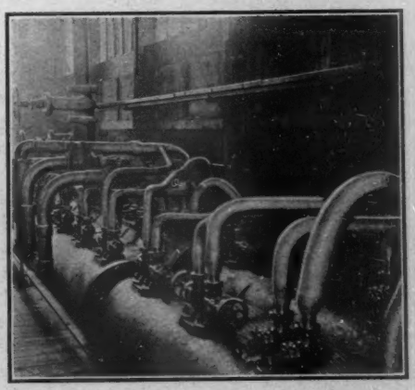
The traffic carried on the street tubes on a typical day, March 10, 1921, amounted to 28,851 messages sent to out-offices and 22,362 messages arriving at the C. T. O. The total yearly tube traffic is about eighteen million messages. The quantity of air used per minute for the street tubes during the ordinary busy hours from about 9 a. m. till 5 p. m. is 260 pounds. Of this, 120 pounds are taken from the low vacuum main which serves the house tubes and 140 pounds from the high vacuum main which serves the street tubes; 70 pounds are delivered to atmosphere and 190 pounds are delivered into the pressure reservoirs. The kilowatt hours used weekly vary from 37,000 to 45,500.

Future improvements in the London tube system are likely to be made in the following directions. When the pumps are worn out or when a similar plant is wanted, high pressure blowers may be used instead of the reciprocating compressors. An additional tube centre may be installed in the West End and four or more trunk tubes worked between the new centre and the C. T. O. A new type of switch which will eject carriers automatically from the street tubes and signal the arrival of carriers automatically to the sending end may be introduced. Some of these matters are being considered at the present time.

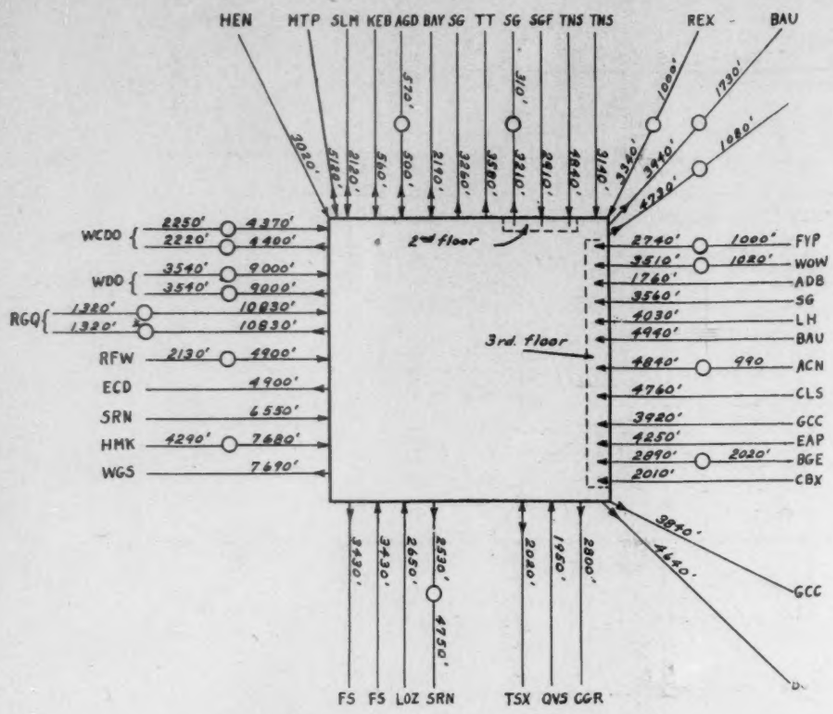
In Berlin there now exist two radial systems. A new head telegraph office was built in 1916 and was connected with the old pneumatic tube centre by four tubes. Additional tubes were laid from the new H. T. O. to seven out-offices so that it forms a centre of thirteen tubes. The air compressing plant consists of Diesel motors coupled to two cylinder compressors. The fly-wheel of the set is arranged for carrying a belt in order to drive an electric generator to supply current to the whole building if the public electric supply fails. The pressure cylinder sucks air partly from the vacuum mains and partly from atmosphere by way of a Bollinger filter.

The street tubes are of iron about two and

Cable companies' tubes on the 2nd floor



Central Hall, back of the main frame.



London street tubes to public offices.

one-half inches in diameter. The tubes between the old and new H. T. O. are worked intermittently. Pressure is first turned on at the sending end and when the train of carriers reaches half way, pressure is turned off and vacuum is turned on at the receiving end. The speed of the carriers which is considerable for the amount of air used is 56 feet per second on the 1,500 yard tube. These four tubes between the two head telegraph offices at each end pass through a 4-way two position switch, by means of which the direction of travel of carriers in the street portion of the tube can be altered; thus the street portion of say tube No. 1 at the H. T. O. end is under pressure one day and under vacuum the next day, and so on. This gets rid of the trouble from moisture, which is condensed in the tubes worked by pressure as the air expands. The moisture is evaporated into the air in the tube worked by vacuum. The tubes generally are provided with draining valves through which condensed water may be blown out by means of pressure.

The terminal apparatus in use in Berlin is relatively heavy. The carriers are not sent singly as in London, but a series of from one to five "message" carriers along with a buffer or "engine" carrier are put into the tubes at one time. The receptacle must be strong enough to receive the impact of such trains. Each terminal box is fixed on a cast iron pillar and is provided with a lot of gear, pressure and vacuum gages, supply pipes and cocks. The loading and unloading takes more time than in London but it is done less often as trains of carriers are used. The traffic capacity of the four tubes between the head telegraph offices is 80 trains of five carriers with twenty telegrams per carrier, totaling 4,000 messages each way per hour. Descriptions of the tubes are to be found in *Zeit. ver Deut. Ingr.*, Vol. 61, pg. 709; 1917 and in *"Beschreibung der Post Anlagen in Berlin,"* published in 1908.

TRADE WITH SPAIN

The American Chamber of Commerce in Spain intends to edit in the early part of December a special number of its Monthly Bulletin and has requested publication of this notice for the information of those who might wish to avail themselves of its special edition and of the valuable information contained therein. Full particulars may be had from the American Chamber of Commerce in Spain, Rambla de los Estudios 8, Barcelona, or from Mr. Eugene L. Perea, care Messrs. Boera Brothers, Staten Island, Ferry Terminal Building, New York City.

A microscopic examination of the mineral constituents of kaolins is being conducted at the Ceramic Experiment Station at Columbus.

SHAFT SINKING RECORD IN TINTIC DISTRICT

THE WORLD'S shaft sinking record has been made in the Water Lily shaft of the Chief Consolidated Mining Co. in the Tintic district, Utah, by the Walter Fitch, Jr., Co., shaft and tunnel contractors, under the supervision of J. D. Matheson and H. W. Jarvis, foreman, reports *Engineering and Mining Journal*. The shaft is vertical and divided into three compartments 4 ft. 4 in. x 4 ft. 6 in. each. The surface equipment consists of two small hoists and two compressors which are operated electrically. Hoisting was done through two compartments with seventeen cubic feet rim-hung buckets. These buckets discharged their load on top by means of an automatic dump (partly shown in the accompanying cut) into eighteen cubic feet tram cars. No crossheads are used, but the hoisting compartments are lined with lagging on the inside and the entire shaft is lined on the outside. Eight by eight shaft timbers were used.

The first 367 feet of sinking passed through a porphyry formation which proved to be favorable mucking material but offered difficulties in drilling on account of its sticky character. The last 60 feet consisted of what is known locally as white lime shale—a moderately hard, close-grained limestone.

The sinking was done on a three-shift basis with an average of 5.7 shaftmen per shift. Most of the timbering was done on day shift and on the four o'clock shift. Shaft sets were placed at the rate of 2.8 sets per day by an average of 4.8 timbermen. The timber was installed from a suspended steel bulkhead, which hung from the last set and made it possible to carry on the timbering and mucking or drilling operations simultaneously. An average of 72.5 buckets of muck were hoisted each shift. It was necessary to drill 23.9 holes for each round. The average powder consumption was 15¼ pounds of gelatine powder per foot. The average footage per day was 13.8 feet, making a total footage for the 31-day period, from July 15 to August 15, of 427.5 feet. All men were paid the standard scale and a bonus that increased proportionately with the footage. During the 31-day period shaft operations were delayed thirteen hours on account of failure of power and headframe repairs.

Shaft sinking crew, Water Lily shaft, Eureka, Utah.

AN AUTOMATIC AIR SHOVEL

AT A RECENT meeting of the Société de l'Industrie Minérale, M. Clapier described a simple form of automatic shovel, driven by compressed air, for filling coal, stowing waste, and other analogous operations. *The Quarry and Contractors Journal* reports that the compressed air acts as a sort of "servo-motor" for raising and tipping the bucket, the latter being directly manipulated by the workman. A chain attached to a piston driven by compressed air, after passing over a pulley placed above the loading point, is hooked on to the bucket. The motor itself comprises a simple tube, 62 mm. in diameter and 2.85 mm. in length, which can quickly be slung in whatever position is required. It weighs, all told, about 57 kg. The stroke varies from 1.20 m. to 1.50 m. A small piston equipped with a recoil spring is placed at the rear of the cylinder. Control is exercised by the movement of the chain, a relatively small tension on this compressing the spring of the piston, called the auto-exciter, and causing a relative displacement of the piston with respect to the ports of the cylinder, thus allowing air to be admitted on the front of the motor piston. The load when raised remains suspended by the air pressure, the tension exercised on the chain maintaining the spring of the distribution piston compressed and the air inlet open. As soon as the bucket is emptied, this tension becomes insufficient to maintain the requisite pressure on the spring of the piston, and the air is exhausted, while the inlet is closed, thus causing the bucket to fall again to the ground.

The bucket may take different forms, according to the material to be loaded, and the base may be replaced by a fork or grid. The workman pushes the bucket into the pile and rakes the material into the same, afterwards giving a slight tug to the chain. By the modification shown in Fig. 2, further economy of labor may be secured. In the first instance, the vertical chain being slack, the bucket, under the action of the oblique chain swings over the ground and penetrates the mass. As soon as the vertical chain becomes taut, it is raised, describing a hyperbola.

Tests of the appliance have been carried out in a thick seam at Montrambert, and by means of it a youth of sixteen has been able to fill without fatigue an average of 40 tubs per day over a period of several months. Each bucketful weighs about 60 kg., and the complete operation takes about 25 seconds; thus in three minutes a tub of 420 kg. can be fully loaded—a result that may be attained by hand, but not without excessive labor. In practice, it is stated that the output per workman has been doubled, and as many as 80 tubs have been filled per day. For operation in the open air, the appliance is suspended from an improvised jib crane, consisting of a balk of timber slung from a trestle and mounted on a wheelbase.

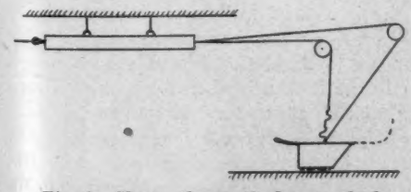


Fig. 1—Shows the vertical rope slack.

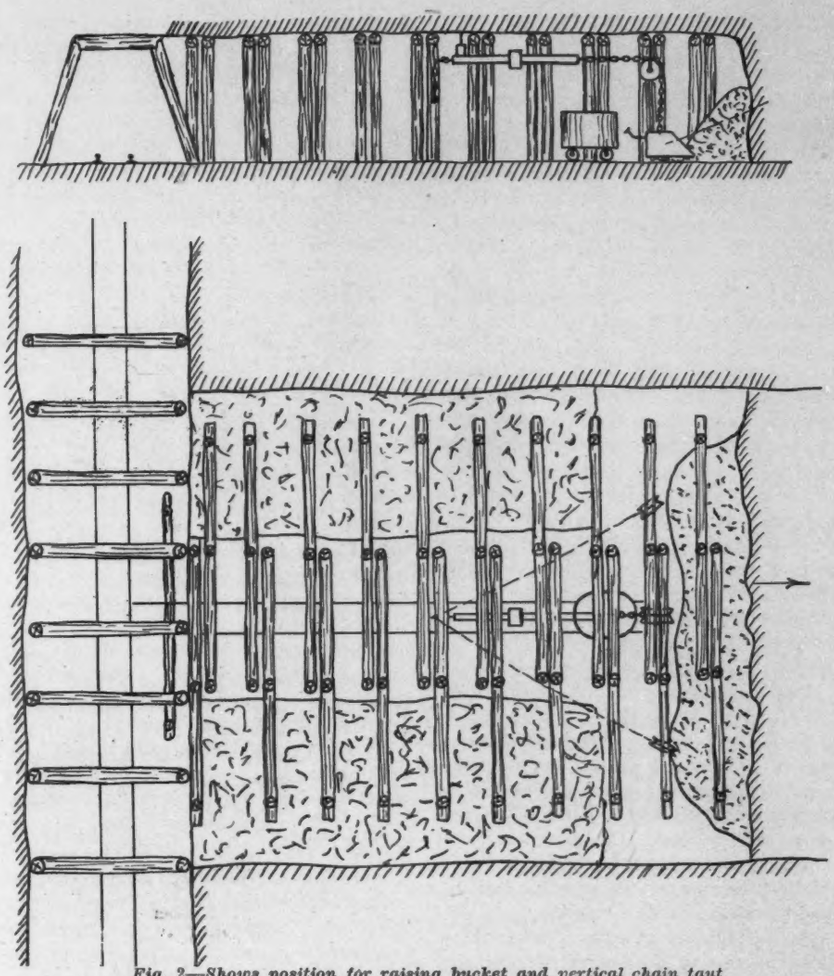


Fig. 2—Shows position for raising bucket and vertical chain taut.

The consumption of compressed air amounts to about five litres at 5 kg. for each bucket load, 35 litres per tram load or about 14 cm. per day, or about a twenty-fifth or thirtieth of the power required to drive a pick machine to get the equivalent quantity of coal. Above ground it has an important advantage over the steam shovel, owing to the low first cost.

A MODEL FOR SHORT STORY WRITERS

The following is a verbatim copy of a label affixed to an exhibit in a museum, and *Scientific American* says it is one of the best short stories ever written. "Far back in the past, during that period in the world's history known as the Triassic, the State of Connecticut was largely covered by the sea, and a bay, or estuary, extended as far north as Turner's Falls, Mass. One day, when the tide was out, one of the great reptiles, known as Dinosaurs, walked along the beach, leaving his footprints in the sand. The tide came in, the tracks filled with sand and mud; in the ages that followed this became stone, and a few million years later, in quarrying stone for New York houses, this track was uncovered."

"FISHING" WIRE THROUGH A CONDUIT BY COMPRESSED AIR

IN A LETTER in the *Electrical World*, Mr. N. B. Hinson, engineer of distribution of the Southern California Edison Co., Los Angeles, Calif., describes how compressed air proved of service in fishing wire through a long conduit. He states that in an installation of street lights in southern California where the runs between outlets were generally 300 feet and often as much as 450 feet it was impracticable to use the usual means of fishing the wire through the conduit. Compressed air, however, proved available, and a small air compressor driven by a gasoline engine was used to supply it. This engine was set on a hand truck and employed in connection with a storage tank similar to those commonly found in rural garages. A pneumatic fishing machine was used with a special cord consisting of extra heavy fish line. In addition to the ease of operation, this method had the advantage that all dirt and foreign matter were blown out of the conduit.

The laboratory work in connection with a general study of the clays of Washington has been completed, and a bulletin on the subject of Washington clays is now in course of preparation.

PAINT-SPRAY FINISHING IN AUTO INDUSTRY

A LARGE FIELD for the use of compressed air is in the finishing department of the automotive industry and allied lines.

Here the spray-painting system for about ten years has been a potent factor in increasing production, improving results and reducing costs. Fully demonstrated has been the practicability of the method and of the equipment.

Hardly a car passes down the road to-day but that has had the major portion of its finish sprayed on. Practically all of the leading and large production companies are big users of the spray system. And those smaller organizations with a limited output not warranting the use of the spray in their own plants, find the finished parts that come from without nearly all spray coated.

The spray-painting system is comprised of the following equipment:

(1) Air compressing plant, including air compressor, motive power, and air receiver with accessories.

(2) Exhausting equipment, consisting of fireproof steel booth in varied sizes in which the work is done, fitted with electric exhaust fans installed in scientifically constructed back.

(3) Spray equipment, embracing the spray machine in attached cup or separate container type, air regulating and cleaning device, electric air and material heater, air duster, air and fluid hose, and overhead gravity feed or pressure feed material container.

(4) Handling devices for every class of work, either air or hand operated.

Evenness and uniformity, as well as thoroughness, of coating are responsible for the high quality work of the spray system. The trained workman obtains these results on any surface with any material.

Finishing processes vary as do the working conditions. These, however, may be considered as average:

Bodies are sprayed with primer, rough stuff, lead coat, flat color, and in some instances with the color varnish.

Chassis and motors, where given a finish coat, are sprayed with enamel.

Interior of motors are given a sprayed coating of enamel sealer.

Wheels, wood or iron are sprayed with filler or primer, enamel and varnish.

Gasoline tanks, headlights, spot lights and wind shields have their enamel coatings applied by spray.

Bumpers, speedometers, visors and other accessories are likewise sprayed, even unto the spraying of wet glaze on spark plug porcelains before they are fired.

In handling these several classes of work, the range of air pressures is from 40 to 80 pounds. Weight and viscosity of materials, together with nature of work, govern this.

Speed of spray-painting over the brush method is of outstanding importance in the automotive field. This ranges from four and five times up to ten times or more. The tremendous saving of time and labor is not the only advantage this feature affords, but it makes possible keeping up in the finishing department with the plant's production schedule. Work moves out as fast as it moves in. There is no piling up of bodies or parts, days behind the progressive march ahead in other departments. Helping to speed up turnover and to hold down overhead have been two prime features of the spray system.

Operation is simple and dependable. The equipment is easily adaptable to individual requirements. Upkeep expense is negligible. Complete removal of fumes from finishing room provides for cleaner and more healthful working conditions; besides, minimizing fire hazard.

Painting the automobile with air brings its advantages and economies to the ultimate owner and driver, as well as to the manufacturer.

This article was contributed by The DeVilbiss Mfg. Co.

Paint spray system used for finishing automobile parts.

COMPRESSED AIR USED IN WASHING CARS

A NEW, effective, rapid and inexpensive method of washing automobiles has been devised, using compressed air to regulate the force under which the water is applied in removing the mud, dust and grease from the motor car.

A nozzle is used which consists of a 3/8-in. pipe about two feet long that has two separate passages under individual valve control. One valve admits the water supply from the city main, while the other, which is attached to the nozzle at an angle, admits the compressed air.

The operator turns on the water and then regulates the air valve until the desired pressure is obtained. This system is especially efficacious in removing grease and grime which accumulate on the axles, springs, shackles and steering knuckles—filth which is almost impossible to remove by hand.

Furthermore, after a car is washed, the attendants can go over the car with the water shut off using the compressed air which ranges from 50 to 125 pounds pressure per square inch, to blow out all the water from the joints and cracks.

A two-cylinder compressor of 7½-inch bore driven by a twenty horse power oil engine is ordinarily sufficient to maintain the air pressure at 100 to 125 pounds in a tank four feet in diameter and nine feet long. The car to be washed is first cleaned thoroughly by the use of compressed air, which removes all dust and dirt from the cushions, upholstery, top and interior of the automobile.

Then the car is pushed forward over a pit in the concrete floor in which there are a number of perforated pipes. Alongside the car are also a series of similar waterpipes which spray water under pressure over each wheel.

When the water is turned on and the air pressure applied, the water is driven in finest reams all over the running gear and underside of the machine. This softens and loosens all the dirt, mud and grease on the chassis.

Then the car is moved forward where other workmen go over the running gear thoroughly with rubber hose, equipped with supplementary air pressure, which are suspended at regular intervals from the ceiling of the shop. They wash and blow away all the filth and foreign matter.

Subsequently, the water valves are closed and these workmen go over the car with the heavy air pressure alone in operation, so as to blow all the water from the crevices, cracks and joints. Then the body of the car is washed and chamoised by hand and finally it is polished in a similar manner.

ORE STEAMER LOADED IN SIXTEEN MINUTES

What is claimed to be a world's record for loading a cargo of ore was established recently according to the dock office of the Duluth & Iron Range Railroad, when the steamer *D. G. Kerr* took on 12,506 tons of iron ore, in sixteen minutes. This office reports that the steamer tied up at the dock at 4:44 p. m., loading and raising the last chute by 5:00 p. m.

The Great Alsatian Potash Industry

Increased Production Made Possible by Adoption of Modern Mining Methods Including Compressed Air Installations Will Challenge German Pre-War Supremacy in the World's Markets

By BEN K. RALEIGH

THE FRENCH Parliament has empowered the Government to acquire the renowned Alsatian potash mines and the portents are that there will be formed a real efficient business organization to work these rich deposits in the national interests.

Immediately after the action of Parliament in vesting the ownership of these mines in the state I made a tour of the Alsatian potash fields. Much is happening there which is likely to have an important bearing on the general economic evolutions of post-war Europe It is evident already that the French, in recovering their lost provinces of Alsace and Lorraine, have regained an economic prize which their fathers and grandfathers in 1871 never imagined they were losing.

These mines in the Colmar, Thann and Mulhouse district, it will of course be understood, were formerly under German operation. It was not until 1910 that the German miners brought up the first yield from the Alsatian mines, to add still further to the great wealth which potash brought to Germany. Between 1910 and 1914 the output was necessarily small, the work being pioneer work of a difficult kind. Then came the deluge. In 1919, according to the statistics and blue prints of production supplied me, the French almost doubled the output and, in 1920, quadrupled it. If present plans are fulfilled a similar rate of increase will be maintained during the next two years. By that time the French engineers estimate that the Alsatian production will amount to 34 per cent. of the total pre-war world production of potash.

Potash is one of the three chief fertilizing elements, the others being nitrogen and phosphoric acid, and the extreme efficacy of its scientific use for the purpose of intensive agriculture has already been proved. It is probably conservative to say, as a general principle, that those farmers who in any country have used potash extensively have had correspondingly amazing results. There are soils, sandy, chalky or peaty, which are almost entirely devoid of potash; others granitic and similar types, contain it in an insoluble state. In almost all soils the use of specially prepared potash fertilizers has proved beneficial. Vegetables, cereals, cotton lands, meadows, vines in particular, have quickly responded to their influence. Holland and Germany have used them most.

The French acquisition of the Alsatian potash will have far reaching effects. It has an immediate bearing on the eternal question of reparations, which perhaps has not been given as much attention as it deserves. Under the Treaty of Versailles, in common with other territories formerly belonging to Germany, Alsace is to be assessed by the Reparations Commission and its value is to be written off against Germany's total liability.

So far, I understand, nothing has been paid to the Reparation Commission out of the proceeds of the mines, because all the available surplus has been swallowed up by capital outlays on extensions, improvements, the building of miners' cottages, the purchase of modern machinery for mining, and the like.

Wittelsheim is a potash mining town, created in its present model spirit by the French. The journey had been over-night in a sleeping car from Paris to Mulhouse; then in the early hours of the morning by automobile from Mulhouse to Colmar, and then from there on to Wittelsheim. Word had gone ahead that a correspondent of an American magazine was coming and I found waiting for me in the dressing room a complete new outfit of miners' togs.

I laced hob-nailed boots upon my feet, stuck a rubberized hat upon my head, had my mine lamp inspected and pronounced in good order, and stepped into the cage. A bell rang and in a twinkling we were in the 2,000 foot level.

The cage gave on to a low square space, electrically lighted, with branching galleries and walls of glinting crystals, of a dead pink and white, with a touch of black here and there to sober it, and occasionally, a dash of red. To this square came the trucks, horse-drawn or pushed by men, with their loads of crude potash salts from the face of the seam. This is the potash rock, so powerful a tonic to the soil and so precious a factor in the world's agriculture.

We bent low and made our way along a gallery where the roof rises five feet. I had no thermometer, but I can guarantee that it was not cold down that mine, yet my guide, a buoyant, resilient French mining engineer spoke with all the spirit and presence of a platform lecturer under Chautauqua conditions. And for two hours he marched me about at a smart pace, often along passages too low for us to walk upright, explaining meanwhile the nature of a potash mine, the nature of potash, its uses and its possibilities, the technique of potash mining, the badness of the German methods in this particular mine as he had discovered them, the soundness of French methods not once omitting whenever we came to a low hanging rock to utter a warning to guard hanging rock to utter a warning to guard against a collision of head and stone until I was drenched in sweat and exhausted. He, himself, at this stage, and in fact, at all stages, had all the advantage of a disembodied spirit, cool, calm, dry, enthusiastic.

He gave minute directions as to the holding of the lamp in one hand and keeping the other free for the ladder which I could just see protruding from a narrow hole in front of us. He entered first on the dark descent, calling back instructions meanwhile. On reaching the foot of the first long ladder, narrow, almost vertical, a thin ledge took my feet to the opposite side of the pit to start a second. There were nine such ladders and I believe my engineer was sincerely sorry that he could not offer me many more, but without wasting time on vain lament, he plunged into the darkness of the lower seam.

And so, for the time necessary to make a comprehensive, understandable tour of the mine "Amélie," we went on. And what follows is much of what I learned on that trip and of the part compressed air is playing as a benefactor of society in assisting in making two blades of grass, two kernels of wheat, two bolls of cotton grow where in the past only one had grown.

Before the war the Germans possessed a monopoly of potash. It should be constantly born in mind that potash gives back to the soil an essential quality which intensive cultivation exhausts. Potash deposits have been found only in Germany and Alsace, the richest of these

A DESCRIPTION of the alunite deposits of the United States was published in the last issue of Compressed Air Magazine showing the future importance of these resources as a source of potash with aluminum as a valuable by-product.

In this article the author discusses the future importance of Alsatian mines in supplying the needs of the entire world.

The rich potash deposits lying between Colmar, Thann and Mulhouse (the German Mulhausen) are only beginning to be exploited. But even at this early stage of their new development under French engineers compressed air and compressed air machinery are playing their yeomen's parts in delivering up the salts which make crops grow. Thus compressed air may now justly be said to be assisting in the primary and all important work of feeding the world.

A view illustrating the room and pillar system of potash mining. The illustration shows French miners detecting the beginning of a crack which will later result in a collapse.

deposits being in Alsace, but they were found there only long after the German annexation of the province and Germany has been anxious to keep the potash monopoly in her own country.

It is estimated that the potash deposits around Mulhouse, if worked at full blast, that is by the installation of sufficient modern compressed air mining machines, can supply the needs of the entire world for 300 years. The French say the Germans' prevented this enormous source of wealth, not only to Alsace, but to the entire world, from being developed. The French allegation is, and they have documents, that the German potash monopoly permitted the Alsatians to produce not more than one-tenth of the total amount of potash that came from German territory proper, and thereby kept up the price of potash.

An Ingersoll-Rand equipment at work in far away Europe. The advantages of mining with compressed air machinery are explained by French Government engineers in the text of this article.

Before the war there were three German companies and one French-Alsatian group working the potash deposits in the Mulhouse district. The German companies, which held concessions for two-thirds of the district, were after the war placed temporarily in the hands of an official French liquidator, Senator Helmer, who has since accomplished miracles in the augmentation of output.

The French allege that the methods employed by the German companies in working the Alsatian mines were out of date. Senator Helmer, with the approval of the French Government and the French courts, formed the *"Société Commerciale des Potasses d'Alsace,"* which at once set to work to introduce a modern system of mining, which necessitated compressed air and electric installations, and to challenge German supremacy on the world market. The results of these efforts may be expressed by the following figures:

Under the German regime the greatest quantity of crude salts produced from the Alsatian potash mines was 325,886 metric tons, in 1914.

Under the French regime, in 1920, the same mines produced 1,222,615 tons of crude salts; 1,900,000 metric tons are anticipated for 1921 and 2,400,000 metric tons for 1922.

At the same time experiments were begun to ascertain the quality of the Alsatian potash in comparison with the potash from the German mines, as shown by practical agricultural tests. Another series of experiments had for their purpose the securing of data concerning results obtained by mixing potash with ordinary manure. This last was to obtain facts and figures which would convince the French farmer of the desirability of using potash on his fields. The Government, accordingly has proceeded to show him.

An experimental station was established at Marles, in the Department of the Aisne. The first year that potash salts were used there was an increase of 36 per cent. in the yield of corn and a five per cent. increase in straw; in the second year there was an increase of eighteen per cent. in both corn and straw. In the third year the increase amounted to 22 per cent. in both cases.

So far, so good. The German potash monopoly was at an end and the French farmer had been shown. There remained the task of ascertaining the difference in quality between the German and the Alsatian potashes and of letting all the world know the result.

The situation was this: that in all the world there are known now only two sites where potash can be obtained in commercially successful quantities. One is in the Alsace region of which this article treats; the other at Stassfurt, in Saxony. The Stassfurt deposits are far larger than those of Alsace and they pos-

sess no less than 206 shafts; while those of Alsace possess only seventeen mines; but the Alsatians put forth the claim that chemical analysis and practical tests both prove that the Alsatian deposits are almost twice as rich in potash as the German and that for all practical purposes they may be regarded as inexhaustible.

The potash salts of Alsace are of three kinds:

Sylvinite 14% (French kainit; kainit being the German name for the crude salts)
Sylvinite 20% (French manure salts)
Muriate of Potash, 50%-60% potash, K_2O.

The sylvinites are the raw materials of the mines of Alsace and undergo no treatment except crushing to make them suitable for distribution. The French analyses of these salts supplied me indicate that they are much richer in potash than "the low-grade salts which were supplied by the German Potash Syndicate." The French Government authorities gave me this official assurance:

"Sylvinite 14% contains 14-16% pure potash K_2O.

"Sylvinite 20% contains 20-22% of potash K_2O.

"Against these the German mines can offer only caranallit, containing 9-12% pure potash K_2O and kainit, containing 12-13% pure potash K_2O.

"The Alsatian sylvinites contain considerably less chloride of magnesium than the German salts and also less moisture; they consequently offer greater facilities in regard to handling and transport and do not give trouble in storing."

Remark was made also of the vain efforts made by the United States from 1910 until the outbreak of the war in 1914 to assure for American agriculture an interest in the German potash industry for the sole purpose of obtaining some sort of independence in its potash supplies.

All this is of importance to America, for in 1913 the United States imported 250,000 tons of K_2O. This supply was cut off during the war. Numerous plants, using every available material started to manufacture potash in America and produced in one year as much as 50,000 tons of K_2O.

The Alsatian mines anticipate that the United States will become their largest and best potash customer. Thus Graph No. 1 (page 10289) shows the ascending curve representing the crude potash salt extraction. This graph has been extended for the two coming years, the calculations being based on the work which is being done at present. It will be seen that the end of 1921 should see a production of almost two million tons and the year 1922 two and one-half million tons. Graph No. 2 (page 10289) shows the extent of the development of the refining plants, these plants turning out the salts containing the high percentage of potash. When establishing this curve the future was also considered, the figures being based on plans being studied and worked out at present.

These two graphs lead to the following conclusions: Before the war, production of potash in Alsace amounted to only three per cent. of the total world potash production; it reached seventeen per cent. with 1,222,615 tons in 1920, which is 21.5 per cent. of German production. During the coming two years the mines will be able to furnish 400,000 tons which will be 34 per cent. of pre-war world production and one and one-half times the American demand.

The supporting walls are cracked and the roof is in danger of falling. Two days after this photograph was taken the roof fell for a distance of several meters.

At the present time the plants connected with the mines produce 4,000 tons of pure potash per month in the form of muriate of potash. This figure is gradually being increased, the aim being to reach 11,000 tons in the early months of 1922 and to supply a total of about 120,000 tons in that year. This last figure is superior to the total American purchases of muriate in 1913 (116,402 tons). New plans for plant are being examined. These will increase the production of refined salts in proportion to the development of extraction.

In order that the reader may get a perfect idea of the relation between the Alsatian mine production and the American consumption there is shown on Graph No. 3 (page 10290) on the same scale, the American 1913 consumption of the different potash salts as well as the Alsation 1920 production and 1922 prospects. Thus it will be readily seen how easy it will be for this Alsatian industry to furnish America with high percentage salts, either twenty per cent. crude salts or high grade muriate. These are the only two kinds which may be considered for export on account of the cost of transportation.

Graph No. 4 (page 10290) shows the distribution of Alsatian potash sales. It will be seen that France and the United States bought about three-quarters of the Alsatian production.

The future plans for the development of these mines are comprehensive and at the time of my visit four shafts were being drilled at

These men are eliminating the possibilities of danger caused by the room and pillar system of mining. Waste matter from the refining plant is returned to the mine, all the pillars are extracted, and their potash content used and the room filled up solidly and safely against all danger of collapse, with the waste.

The four-meter bed. This illustrates another view of the room and pillar system which the French engineers condemn so severely as criminally wasteful. This system is still used in some American coal mines.

Ensisheim and Wittenheim ("Anna" mines) and, incidentally, at this new Ensisheim mine potash has already been struck. By the time these new mines will be ready to be worked the Alsatian potash deposit, it is calculated, will yield 4,000,000 tons of crude salts, or 650,000 tons of K_2O. A new location is also being prospected for the erection of a twin-shaft mine on which initial work may be started within a few months. A rapid increase of production in proportion with the world demand therefore seems assured.

With these figures in mind, I felt inclined to ask how the situation of the Alsatian mines compares with that of their German competitors. I wanted to know whether the German mines would not be overwhelmingly superior to the Alsatian with their 200 shafts and their large potash production. I inquired whether the French thought they could hold out in the fight against the Germans. I addressed this inquiry to Monsieur Bucherer, one of the officials. He was emphatic in his reply.

"Mais, oui," he retorted. "Yes, decidedly we can do it. I shall give you two statistical figures and they shall tell you why.

"In November, 1920, the German mines produced 1.4 tons of K_2O per man per month while we were able to reach more than twice that figure, 2.9 tons. The 1919 figures establish exactly the same proportion.

"In 1920 the average content of pure potash of our salts was 16.4 per cent., whereas for many years the German salts contained only 10.5 per cent. When comparing these figures one cannot help but come to the conclusion that our Alsatian mines contain not only richer salts but that they are being worked more efficiently. As a matter of fact since the German potash monopoly was broken up, half of the German mines have been unable to continue working and their management seriously considers closing up those mines giving an unsatisfactory yield so as to be able to concentrate all efforts on the plentifully yielding mines. For two years we have had the opportunity of witnessing the ascendency of the Alsatian mines at the expense of the German, which we consider to be on the down-grade."

We spoke about the wealth of the Alsatian potash deposit. For the last two years the newspaper press of two continents has contained references to this subject. As far as engineers are able to estimate the deposit contains about 300 million tons of K_2O, or, as I have previously said, sufficient to meet the needs of the world for 300 years.

"But," said Monsieur Bucherer, "I must tell you what the Germans did that this figure might remain purely and merely theoretical. When taking possession of the mines after the armistice we were surprised to find out how rudimentary the German working methods had been. They employed the so-called room and pillar method, leaving as the work advanced, about 50 per cent. of the potash salts down in the mines. I know quite well that this method is used in a large number of your American coal mines, but for years your Bureau of Mines, supported by the most eminent of your engineers, has been making a vigorous campaign for the sake of preservation of the national wealth and directed against the wasteful mining methods of a passing generation.

"It is true, however, that if these methods are sometimes used in America it is on account of the abundance of all sorts of products; in the case of the Alsatian potash it meant absolute and criminal recklessness. As a matter of fact at a depth of 600 to 800 metres the slate layers beneath the pillars are unable to resist the heavy pressure and after a relatively short time they prove to be not strong enough to bear the concentrated weight. Our first task was, therefore, to introduce a new working method consisting in filling up the excavation with plant waste matter. This sort of work is somewhat costly, it is true, but it makes our mines 50 per cent. safer and improves ventilation which is extremely important considering that the temperature at this depth is 40 degrees. Centrigrade.

"Generally speaking I may also mention that workshops, warehouses, homes for the entire staff and the mines were completely lacking which only goes to prove, to my mind, how little the Germans intended to avail themselves of the Alsatian mines. The principal difficulties we encountered, however, were due to the damages caused by five years of war. As a matter of fact, when we took possession of the mines they were completely neglected, the machinery was rusty and the buildings battered by shells.

"Moreover, almost the entire technical staff as well as the commercial staff were composed of Germans who were obliged to leave the country. Files and records had disappeared. Everything had, in fact, to be done with a new and inexperienced staff. Work was stopped several times on account of strikes, one of which lasted two months. It may be readily understood that our activities were

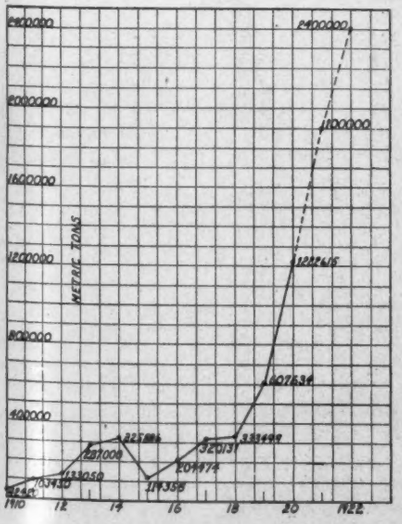
The cracked pillars in a potash mine are blamed by the French Government experts on hasty and wasteful mine engineering methods.

seriously hampered by these events and because of them we were not able to deliver our first orders as rapidly as was desirable. This, unfortunately, gave the impression to some people that we were unable to supply the demands of the United States.

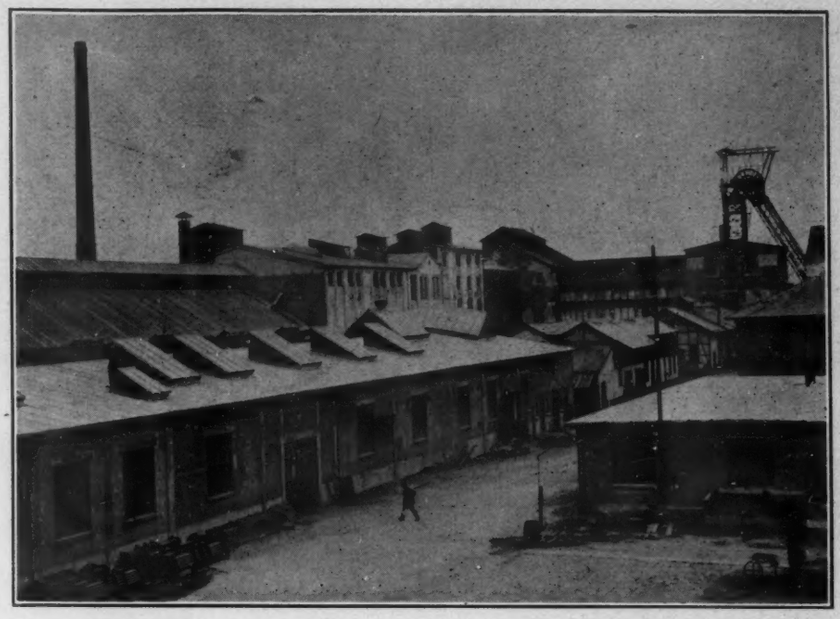
"Other persons held the belief that because the former German mines had been put under sequestration, production had been curtailed. This is quite wrong, however, as the sequestered mines have produced up to the present 90 per cent. of the tonnage extracted."

The Government's sequestrator, Senator Helmer, assisted by Alsatian banks, succeeded in stimulating all activities and now war damages have been repaired and both the technical and commercial staffs have been built up to a high state of efficiency. New buildings are to be noted everywhere on the mine field, new shafts are being sunk, both on the territory of the French-Alsatian group of Monsieur Vogt and on the sequestered part of the potash deposit.

In the splendidly equipped laboratory I was able to examine rapidly the utilization of potash in agriculture. Let us review briefly the position as I saw it there. Potash is, with nitrogen and phosphoric acid, one of the three principal fertilizing elements, indispensable to the growth of all vegetable matter. Among the different nutritive principles of which the soil is deprived by the various crops of our cultivated plants, potash has, according to chemical analysis, proved to be in a greater quantity. An intensive culture, i. e., the cultivation of the soil so as to secure the largest production on a certain given surface, cannot rely only upon the reserves of mineral elements that every soil, whatever its structure may be, contains in a larger or smaller quantity. To obtain a sufficient supply of foodstuffs for the feeding of the world it is indispensable to have more and more recourse to chemical fertilizers, and particularly, to potassic ones. Not only the numerous experiments made by eminent agronomists in every country have given a full evidence of this fact, but their constantly increasing use in agriculture has also shown it most clearly.



Alsatian potash mine output, 1910-1920 in metric tons of crude salts.



"Amelie" mine buildings. How near these buildings are to the mine proper may be seen from the picture which shows the cables, wheels and top of the shaft elevator. The mine is a "spotless town," potash mining being the cleanest mining of all.

The countries which are the greatest consumers of chemical fertilizers are also those which obtain the best crop production.

However, it would be puerile to conclude that potash is the only regulator of the output, but the statistics state clearly and practically that whatever may be the qualities of a soil, climate considered, the agricultural future of a country depends upon the more extensive use it will make of the various chemical fertilizers, united with the best cultural methods.

For a long time, according to chemical analysis summarily interpreted, or even due to purely theoretical ideas, most of the cultivated grounds had been thought sufficiently rich in potash. Consequently the uselessness of fertilizers containing this fertilizing element had been taken as established. Then came an awakening. It was determined that soils entirely or partially deprived of potash existed, these being peaty, sandy and chalky soils. On the other hand many heavy soils which were reputed as containing a great quantity of potash were found in fact to possess very little. Last of all, in an important proportion of the soils really rich in potash (granitic and similar soils) potash exists in an exceedingly insoluble state, so that plants can derive but little profit from this richness. This is due to the fact that the secretions of the roots have but a very slight dissolving power.

Then came experiments which showed the efficiency of potassic fertilizers, even in the best and richest soils. Now, chemical analysis does not authorize positive conclusions except when giving a negative result. The plant is the supreme judge in the assimilation of the existing potash. Only comparative and repeated trials can determine whether the composition of a soil is sufficient to obtain the largest possible crops, a case which can be considered as practically not existing.

What characterizes essentially the "attitude" of potash in the soil is that:

1st—Contrarily to what takes place with other fertilizers, potash is fixed, absorbed by some of the elements constituting mould, humus and clay; being held by the ground it cannot be dissolved and washed away in great quantities by the infiltration of water.

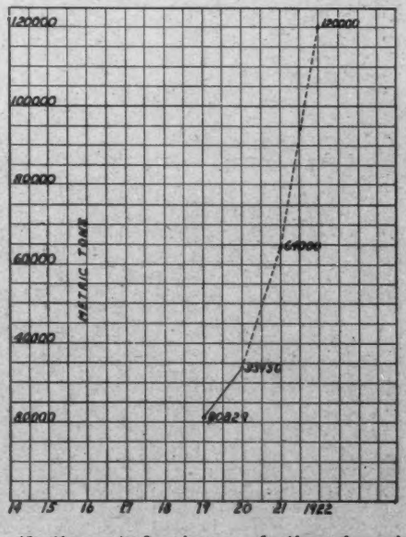
2nd—The potash so stored remains at the immediate disposal of the plant life without having sustained any loss.

Capital consequences result from these two things:

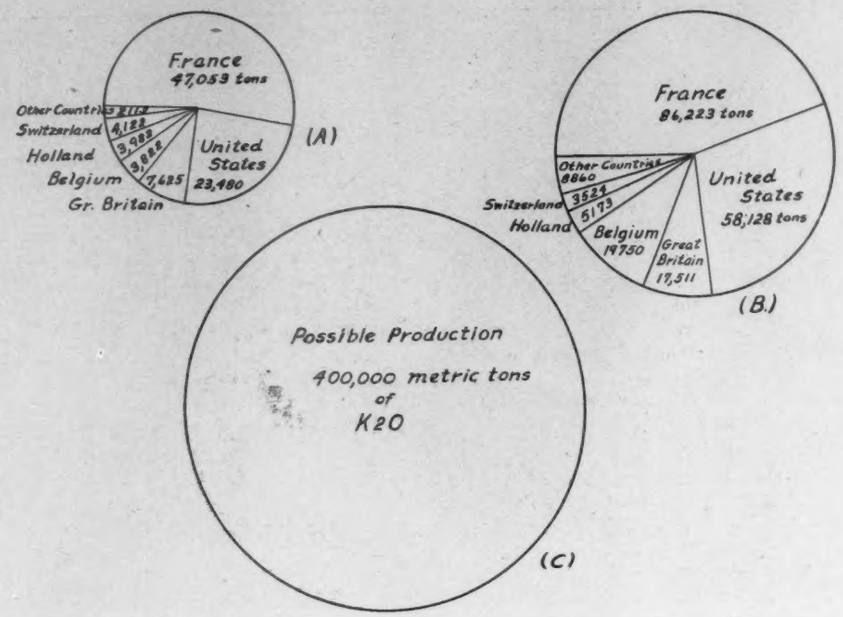
1st—Potassic fertilizers might be used a long length of time before being actually called into use, as there is no fear of important losses through the drainage of water.

2nd—Potassic fertilizers can be dispensed superabundantly. What the first crop cannot make use of will be used by the following crops and during the ensuing years.

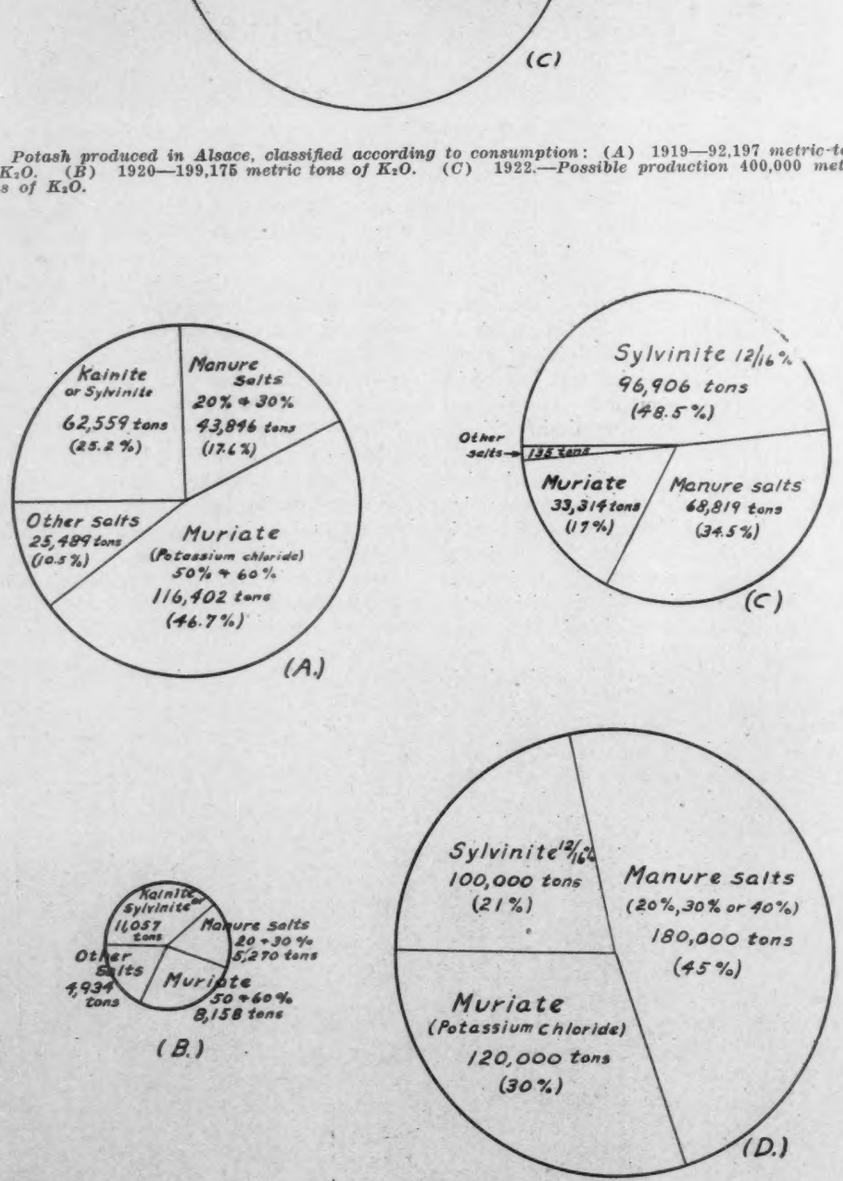
It has also been ascertained that beside their favorable action in stimulating vegetable



Alsatian potash mines production of muriate (potassium chloride) in metric tons of K_2O.



Potash produced in Alsace, classified according to consumption: (*A*) 1919—92,197 *metric tons of* K_2O. (*B*) 1920—199,175 *metric tons of* K_2O. (*C*) 1922.—*Possible production* 400,000 *metric tons of* K_2O.



(*A*) 1913—*Potash imported in the United States*: 248,296 *metric tons of* K_2O. (*B*) 1913—*Potash imported in Great Britain*: 29,419 *metric tons of* K_2O. (*C*) 1920—*Potash produced in Alsace*: 199,175 *metric tons of* K_2O. (*D*) 1922—*Possible production of Alsatian mines*: 400,000 *metric tons of* K_2O.

growth, potassic fertilizers have an influence on the soil itself and on the biologic and chemical phenomena which it undergoes. In numerous trials it was ascertained that they delayed or even prevented ground frost by lowering the freezing point of the solutions. In summer the hygroscopic state of these fertilizers gives a certain freshness to the soil. The potash favors also nutritious action, so essential to the utilization of ammoniacal or organic nitrogen by plant life.

Now, plants are cultivated specially for the foodstuffs they accumulate in some part of their organism. There is, for instance, starch in cereals, fecula in potatoes, inuline in Jerusalem-artichokes, sugar in beet-roots and in fruits such as grapes.

In order that the reserves of these foodstuffs be abundant, that is, in order that the output of cultivation be of a high standing, the assimilation of carbon has to be extremely active. In developing the surface of the foliage, in favoring the formation and then the work of the chlorophyl (the green coloring matter in plants) potash plays an essential part in the production of hydrates of carbon. Then it facilitates its circulation, or, as it is said, its "migration" from the leaves where it is produced to the tissues where it is stored, such as roots, tubers, fruits or seeds. It is therefore a factor of capital importance in obtaining abundant crops.

Besides this immediate action on the yields potash increases them also in an indirect way. By the normal development which it ensures to the leaf-like organs and by a better formation of ligneous tissues it renders the plant more apt to resist the sources of destruction or the weakening to which it is constantly exposed.

Compressed air is now being largely used in the sinking and excavation of the galleries and mine levels, drifts and creep-holes and in the *"hors couche"* work, for the cutting down and clearance of seams and similar mine work.

Compressed air is also used for subterranean transport, there being compressed air *"treuils."* Let us examine these various compressed air applications in the potash mines.

In the work of potash mine shaft sinking, compressed air plays the part of a Premier. The ground to be penetrated is of compact clay, of chalk and of rock-salt formations, with a depth of 400 m. There is only one single water level impregnating from 0 to 30 m. in depth the gravel of the Rhine Valley. The seams of potash appear between 400 and 900 m. This makes the use of explosives possible in the mining operations and, in consequence, compressed air for excavation work is employed on almost the whole depth of the pit.

The Alsatian mine practice is to reckon, for a shaft of five metres in diameter, on the use of five hammers. These demand the installation of a compressor of about 50 horsepower. The compressors employed are *"bietagés"* cylinders with refrigerating intermediaries compressing at an effective pressure of from six to seven kilograms (thirteen to fifteen pounds). The perforator hammers weigh about thirteen kilograms and consume

about 220 litres (770 cubic feet) of air at 6 kilograms (thirteen pounds) per minute.

On clearance work, for the excavation of the *"travers-bancs,"* where it is necessary to go through seams of slate and banks of anhydrite, a quite stubborn material to deal with, it has been found practical and eminently successful to use compressed air furnished by a small compressor placed at the bottom of the mine and electrically operated. But the engineers have not perfected these installations as yet and point out that their operation at present possesses the great inconvenience of necessitating an addition of special water in order to cool the compressor,—an exceedingly delicate problem in a bed of salt. Consideration is being earnestly given to devising some method by which this difficulty may be surmounted.

In the cutting of potash from the seams and the clearance of the salts only one miner is engaged. Two loaders, however, are necessary to raise the hewn salts.

"What is the net result in your experience and practice?" I inquired of my artistic enthusiastic engineer-guide.

"Summing it all up," said he, "there is great economy over manual labor and man power in the use of the compressed air hammer."

And France is very short of man-power!

Another most interesting development is taking place at the Reischland Mine. Here the engineers after a long study of their particular problem have decided to install compressed air locomotives. With this end in view there are being put into place two compressors of 250 horse-power, using each 750 cu. m. per hour which they compress at 150 kilograms. This air is stored at the bottom of the tubes. The locomotives are Five-Lille triple expansion.

Thus, compressed air in these potash mines of Alsace, procures a vast economy of manual work and of explosives, permits the excavation of drifts so narrow as to be impossible with any other machine or method except by the costly hand system. It also, and this is of extreme importance, adopts itself with more facility to the mined seams and to an irregular bed.

And again—score another for compressed air—the expansion of the air in the fetid and confined space, makes the atmosphere fresher. This has been noted several times to amount to as much as several degrees cooler, quite a difference, let one say who has been through it and suffered. It has been remarked that all the miners want to be where the compressed air machine is at work and that they try to shun an order which takes them out of the sphere of exhaust compressed air. The compressor, in a word, makes the miner's work more healthful, more endurable, he works willingly and with spirit in its neighborhood and the result is that production figures jump in the compressed air section.

Mr. R. H. Bacon, formerly of the editorial staff of *Electrical World*, New York, has been appointed advertising manager of the Imperial Electric Company, engineers and manufacturers of electrical machinery, Akron, O.

FIRST INTERNATIONAL AIR CONGRESS

An important gathering, the first really international air congress, is being held in Paris during the present month of November, extending over about ten days from the middle of the month. It is held under the patronage of the French Under-Secretary for Air, and will be participated in by all the French associations connected with air transport. It is hoped to secure the attendance of the leading British experts. The subjects to be discussed will range over a wide area and should throw light on some obscure points, and perhaps enable some disputed questions of an international character to be settled.

HIGH PRESSURE STEAM

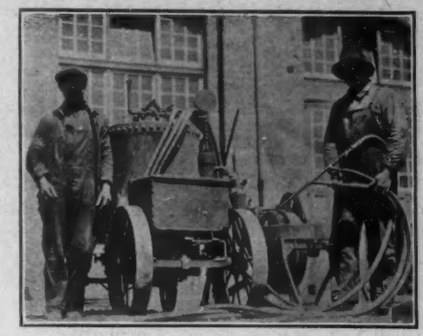
At the latest annual meeting of the Society of German Engineers a paper was read in advocacy of the use of steam up to 60 atmospheres. Results, it was said, have proved the objections against the use of superheated steam of such high pressure were unfounded. In point of view of heat economy, steam engines of up to 1,500 h.p. supplied with steam at a pressure above 30 atmospheres—when the pressure drop was utilized in several stages—proved far superior to the best steam enginesoperated with ordinary superheated steam.

HYDRO-PNEUMATIC SAND BLAST FOR BOILER SCALE

By C. W. GEIGER

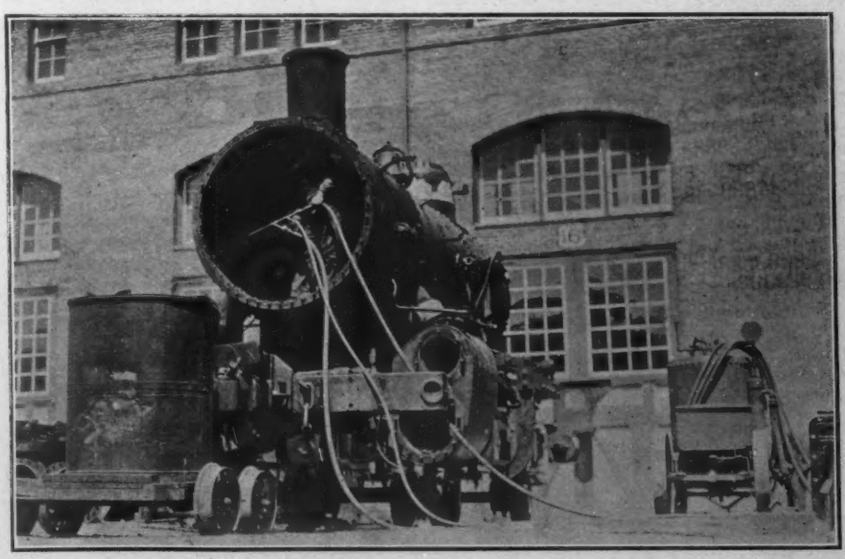
A SAND blasting apparatus in use in a western railway shop which has been especially built for the purpose of cleaning scale from boilers and flues is shown in the accompanying illustrations. This device is a radical departure from the usual sand blasting apparatus, in that water at 125 pounds pressure is mixed with the sand and compressed air, which it is claimed not only gives the sand greater cutting power, but settles all dust and sand that result when compressed air and sand are used together.

The sand blast tank is carried on a four-wheel truck, which enables it to be moved from place to place readily. The sand is placed in this tank, and then a head of air turned in on the top of the sand, sufficient to force the sand through the hose into the gun. The water at 125 pounds pressure and the air at 90 pounds pressure force the sand out of the nozzle of the gun against the flues and boiler, cutting the scale away as if it were mud. As the scale is cut away it and the sand are carried down by the water. By adding the stream of water to the sand blast, all dust and sand are washed down, thus eliminating the one disagreeable feature of sand blasting, that is, the discomfort to the sand blast operator and the adjacent workmen resulting from the dust and fine sand being blown through the air. By this new system, other workmen can work very close to the sand blasters, and the sand blasters can work without using masks.



Showing the sand blast outfit mounted on a four-wheel truck.

It is reported that seventeen railway bridges are to be constructed at a cost approximately of £200,000 in British South Africa. Five 150-foot steel spans will be required for the Vaal River alone. It is also proposed to construct 200 miles of railway through the diamond mining district of Griqualand West, thus helping to link up Angra Pequena with Delagoa Bay, securing a west coast port 100 miles nearer to Europe than Cape Town.



Gun used in sand-blasting.

CHART FOR MEASURING TENSION IN LEATHER BELTS

By W. F. SCHAPHORST, M. E.

(Copyright, 1921, by W. F. Schaphorst).

THE QUESTION is often asked, "How can we measure the tension in belts while they are on the pulleys?"

Here is a chart that the reader will find of much assistance for determining the tension in horizontal or nearly horizontal belts. No tension indicating instruments are needed whatever. It is simply necessary to know the span of the belt or the distance between shaft centers, in feet, and sag of the belt at the center as indicated in Figure 1. It is a simple matter to measure the span of course and the sag can likewise be measured with great accuracy by simply sighting across from pulley edge to pulley edge and measuring the distance from the straight line connecting the two pulley edges to the point of maximum sag in the belt.

Figure 1 shows a belt that is pulling a load. That is, the lower half of the belt is tight. Of course, no horizontal belt is ever perfectly straight even on the tight side, as shown in the sketch. There will always be a sag even while the belt is running with sufficient accuracy to determine closely the tension in the tight side of the belt.

The tension in the slack is of course easier to determine while running because it invariably has much more sag. When the belt is not running at all, and when it is not pulling any load, the sag in the upper and lower half of the belt is usually the same at which time the so-called "initial tension" is easily measured in this manner. After knowing the sag and span, all that one has to do is to run a straight line through the corresponding figures in the chart, Figure 2, and the tension in the belt in pounds per square inch is quickly determined in column C.

For example: What is the tension in a leather belt having a span of twenty feet and a sag of six inches?

Run a straight line through the number six, line "A," of the chart and through the twenty, line "B," and the intersection with line "C" gives the answer as 42 pounds per square inch.

The range of the chart as will be noted is great enough to cover all ordinary cases.

According to the United States Bureau of Standards single leather belting should have a strength of 400 pounds per square inch, and double leather belting a strength of 3,600 pounds per square inch. It is stated that the tensile strength of chrome leather varies from 8,500 to 12,000 pounds per square inch.

To increase the convenience of the chart it might be well to point out that if the sag were 0.6 inch instead of six inches the same dotted line drawn across the chart would show the tension to be 420 pounds per square inch instead of 42 pounds per square inch. In other words by moving the decimal point one place to the left in column A you move the decimal point one place to the right in column C. By remembering this it becomes an easy matter to determine tensions very accurately where the sag may be as little as one-tenth of an inch.

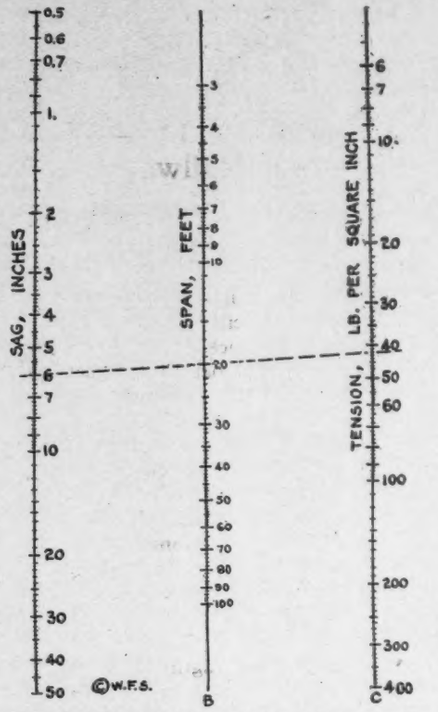


Fig. 2—Chart for determining belt tension in pounds per square inch.

COMPRESSED AIR HAULAGE AT HOMESTAKE MINES*

By GUY J. JOHNSON

Safety Engineer, Homestake Mining Company, Lead, S. D.

UNDERGROUND compressed air haulage was started at the Homestake in 1904, and by 1908 had completely supplanted animal haulage.

Our high pressure compressor installation consists of an Ingersoll Sergeant four stage, cross compound Corliss, converted from steam to electric driven (Dodge rope drive)—with a piston displacement of 2,060 cubic feet per minute—rated to deliver air under 900 pounds pressure at a 5,000 foot elevation; and one Fraser and Chalmers steam end-Ingersoll Rand air end, four stage, cross compound Corliss, with a piston displacement of 860 cubic feet per minute—rated to deliver air under 900 pounds pressure at a 5,000 foot elevation. This latter mentioned unit is only used as a stand by.

On the surface, to deliver ore to the five mills, we have one fourteen ton locomotive, with 8 in. by 14 in. cylinders and a 165 cubic foot air capacity, and two eight and one-half ton locomotives with 7 in. by 12 in. cylinders and 70 cubic foot air capacity. These operate on 22 inch gage tracks, and haul bottom dump cars of 77½ cubic foot capacity.

Underground, we are operating on fifteen levels, with thirty locomotives, over approximately sixty miles of eighteen inch gage track, using both end and side dump cars of nineteen cubic foot capacity. Of these locomotives, seventeen are five ton, with 6 in. by 10 in. cylinders and 40 cubic foot air capacity; three are five ton with 6 in. by 10 in. cylinders and 28½ cubic foot air capacity; and ten are three and one-half ton, with 5 in. by 8 in. cylinders and twenty and one-half cubic foot air capacity. All receive their air charges at approximately 800 pounds, and deliver it to their cylinders at 150 pounds. Their "cruising radius" is two thousand feet with full load, and return. Their charging period is less than a minute, so they can operate continuously without more than the normal stop at the end of each haul.

In spite of the very evident mechanical losses in compressing air above 800 pounds and using it at 150 pounds, our power cost is .0210 (two and one-tenth cents) per ton mile. (With the addition of an Ingersoll-Rand PRE type compressor, and using present steam compressor as a governing unit, we expect to cut this to .013) or .00916 (nine-tenths of a cent) per ton—charging power at .00836 per k. w.—this figure including interest and depreciation on the construction cost of our four power plants.

Our maintenance and repair of compressors, locomotives, pipe lines, charging stations and so forth, cost .0177 per ton mile, or .00768 per ton. One man keeps up all high pressure pipe lines and charging stations. The locomotives are very sturdy and simple, and so have to visit the shops very seldom.

As most of the charging stations are located near shaft stations, our haulage ways and chutes are not much complicated by high pressure pipe lines. The necessary amount of piping is hung in one corner of the back of the drifts, quite out of the way, and its only maintenance cost is an occasional painting.

Maintaining 60 odd miles of trolley lines throughout our workings would be a very strenuous proposition, as a great deal of this mileage would be through timber, working ground, or past chutes, thus being a fire hazard, besides being a direct hazard to the men—particularly in wet sections. Practically all this installation antedates the perfection of storage battery motors, and even now, we doubt if their lower power consumption will more than balance the above maintenance and repair costs.

*Abstracted from paper presented before annual meeting of Mining Section, National Safety Council.

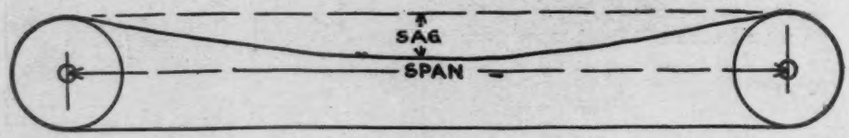


Fig. 1—Shows a belt pulling a load.

Mr. Frank Porter, F. W. Schroeder and Mr. J. E. Walters, who have been stationed at the helium plant at Petrolia, Texas, have been transferred to Washington, where they have been added to the cryogenic laboratory.

The annual convention of the American Gas Association will be held in Chicago Nov. 7 to 12, it has been announced.

Metal Spraying by the Schoop Process

This Method of Metal Coating Promises to be of Great Industrial Value for Applying Zinc or Lead to Bridges, Pontoons, Railway Cars and other Equipment Exposed to the Action of the Elements or Exhaust Gases

By SIDNEY MORNINGTON

THE SUCCESSFUL spraying of metal for coating purposes proved long a technical will-o'-the-wisp to many investigators. Scores of persons chased that *ignis fatuus* only to find their hands empty, so to speak, when they thought they had grasped it. It was plain to all of the searchers that achievement would be well rewarded because of the varied directions in which such a process, if made practicable, could be applied to advantage.

But the bookish man of theory and thousands that let him do their thinking for them were loud in their pronouncement, "It can't be done." Happily for the progress of this world there are creative geniuses that are undaunted by the seemingly impossible. Of such is M. U. Schoop, a citizen of Switzerland. After endless disappointments and battles with difficulties that would have halted most men, Schoop has evolved, step by step, apparatus which make it feasible to do metallic coating in ways that bid fair to profoundly affect the whole art. Once more we have evidence of the adaptability of compressed air to civilization's manifold and multiplying requirements.

The inventor has graciously described for us how he surmounted the obstacles that lay in his path after he once determined to satisfy himself whether or not molten metals could be atomized and sprayed upon metal and non-metallic bodies. Twenty-six years ago Schoop left Russia with 3,000 rubles, all of his savings, in his pocket, and reaching Zürich "once more sat upon the school bench," as he expresses it, to take up the study of physics and the technology of electricity. His studies have borne useful fruit. Let him tell for a while his own story.

"This Spring, to be exact on the 10th of April, I celebrated my fiftieth birthday, and at the same time the tenth anniversary of one of my mental children, i. e., the metal spraying process. Now, it seems but a brief while back that I became convinced, and that while watching by chance the performance of a Flobert rifle, that one might deposit minute particles of metal by forcibly projecting them against an opposing surface. A few years previously I had discovered that the autogenous welding of aluminum could be brought about with the help of alkaline chlorides and fluorides; and the experience thus gained in utilizing the oxyhydrogen flame, together with the work of others in allied fields, stood me in good stead in evolving my metal-spraying process.

"Following my first observations in connection with the Flobert rifle, I made a series of tests in which I employed small canon to shoot tin and lead granules against sheet iron plates which were variously cold and hot. Later on I pursued rather lengthy researches in which I used molten metal in such a way that a thin stream, having its source in a little crucible, was diffused and deposited by the atomizing action of superheated steam or compressed air. These experiments were not without a measure of hazard, for at the time I was of the opinion that it was necessary to depend upon high pressures—from 35 to 40 atmospheres—to obtain the desired fineness of spray.

Subsequent work revealed that much lower pressures would assure a satisfactory diffusion. Thus, successively, pressures were reduced from 40 to 25 atmospheres, then to eighteen atmospheres, and further on I got good results with a pressure of twelve atmospheres. Finally, to my delight, I realized that with proper facilities I could do excellent coating with pressures of from six to seven atmospheres. To-day, owing to continued improvements in the apparatus, the metallisator pistols are meeting commercial requirements and functioning with pressures of not more than three atmospheres.

"The use of metal dust or powder was the second step in the evolution of my system of metal spraying; and the material was projected by a stream of compressed air blown through a concentrically arranged Bunsen burner. The flame of the burner rendered the metal soft or entirely fluid. In bringing out this process my aim was primarily to utilize powdered zinc which is abundantly available in the form of a by-product, and, therefore, to be had cheaply. As is well known, galvanizing is one of the very best agencies for the protection of iron and steel from oxidation.

"My next stage forward in the art came with the substitution of wires which could be melted by a flame or electrically and then sprayed and deposited by the impulse of expanding inert gases or compressed air. For a considerable while I availed myself of the oxyhydrogen flame or a jet of illuminating gas, and then it was shown both industrially and technically that the oxy-acetylene flame was quite 50 per cent. superior. Even so, electricity is by far the more flexible heating medium, because the high temperatures that can be obtained with the electric arc make it practicable to deal with a much larger range of metals. Broadly, the new pistol carries two electrically charged wires, the tips of which are brought together, then separated to induce a short circuit and arcing, after which a suitable mechanism feeds the wires uniformly at a predetermined speed as they are fused. As long as this melting process continues the molten metal is blown from the arc by a strong jet of compressed air operated at a pressure of about three atmospheres. The electro-pistol has been introduced in many factories abroad and functions equally well with either direct or alternating current.

"There is no need to dwell upon the fact that the system and apparatus are the outcome of a decade of tireless labor and painstaking effort along a zig-zag path strewn with obstacles and beset with many difficulties. Ten years ago, when my work was in its infancy, efficiency in surfacing with metals was only about 30 per cent, the remaining 70 per cent was dissipated

A terra-cotta box which has been coated with bronze by the spraying method. The smooth and lustrous finish simulates perfectly the appearance of an all-metal article.

Lead coating the buckets of Pelton wheels for a Swiss hydroelectric plant. The lead is fed to the flame of the metallisator pistol in the form of a wire from the reel in the center of the picture. The compressed air is delivered to the apparatus by one of the three lines converging at the handle of the pistol.

Transmission towers for the St. Gotthard electrified railway which have been galvanzed by the Schoop process. Plainly, it would be exceedingly expensive to provide tanks for the galvanizing of these structures in the ordinary way.

M. U. Schoop and the laboratory apparatus from which was evolved his electro-pistol.

in the surrounding atmosphere in the form of white clouds that seriously hampered breathing. To-day, the efficiency is quite 90 per cent., taking it by and large, and with certain metals, aluminum for instance, the figure is as high as 94 to 95 per cent. In 1911, operations were limited in the main to the use of tin and lead. At present there is nothing to prevent coating any desired object with metals of high melting points, such as platinum, molybdenum and wolfram; and the deposition yields a beautiful, homogeneous surface."

As has been explained, the Schoop apparatus for metallizing surfaces are of three sorts, viz, the so-called "metallisator pistol," a pistol fusing wire with gas; the powdered metal equipment; and the electro-pistol. Each of these instruments has its own distinctive claims to recognition, and functions to advantage under certain conditions. The wire-spray process is the one now chiefly employed; and there are in Switzerland more than 250 concerns working under the Schoop patents. As might be expected, the electro-pistol as well as the wire-spraying gas pistol demands careful and intelligent handling to get the best out of them.

Owing to the sudden expansion of business in the last few years, the pistols have been entrusted frequently to inexperienced operatives, and inconsequent manipulation has led to complaints about the sensitiveness of the mechanism that keeps the wires moving steadily into the fusing flame or melting arc. Heretofore, the advance of the wires has been effected by the action of a compressed-air turbine making 27,800 revolutions a minute, but a gain in simplicity and ruggedness has been realized by substituting in the handle of the pistol a little Pelton wheel which turns at the rate of from 4,000 to 5,000 times in a minute. The latter, of course, is impelled by a stream of compressed air.

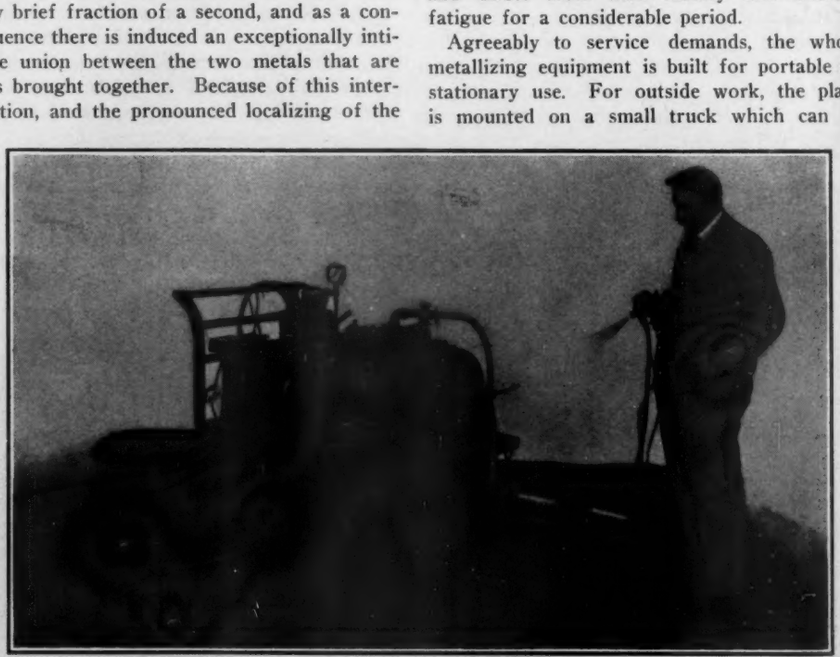
Where powdered metal is readily obtainable it is in the direction of economy to use it rather than to employ wires of the same materials that must be melted to accomplish their diffusion and deposition. This is particularly so when the purpose is to do galvanizing and tinplating in quantity. By this procedure the pulverized metal is delivered by compressed air directly into the flame of the burner or into the incandescent electric arc. The arc, be it understood, is not that across two fusing wires but is formed by suitable carbon or other electrodes, and the temperature is quite 5,400 degrees Fahrenheit.

The glowing cone of the atomized molten metal shows that the spray is virtually at the fusing point when it is projected against the intended object, where it then momentarily imparts some of its heat to that surface but without having time enough to influence to any marked extent the temperature of the mass at large. The cohesive action of the heat is so augmented by the dynamic energy of the stream of compressed air at the moment the metal particles are driven against the impacting surface that these globules are fused in a very brief fraction of a second, and as a consequence there is induced an exceptionally intimate union between the two metals that are thus brought together. Because of this interrelation, and the pronounced localizing of the heat, it seems that readily inflammable and even explosive materials, such as wood, paper, textiles, celluloid, etc., can, after suitable preparation, be metallized without being injured or ignited.

The Schoop system of metal-spraying is something of a paradox at first, for there are phenomena involved that might logically be expected to impair the results. It has been argued by some experts that oxidation would inevitably prevent the formation of a homogeneous layer of deposited metal. The critics have advanced the fact that in all metallurgical processes gas and air decidedly affect molten metal and frequently promote rapid oxidation. "How, then," they ask, "is it possible to preclude this oxidation when spraying metal?" The answer is this: The speed with which fusing, projection and adherence of the metal takes place is faster than that of those reactions which would be necessary to bring about oxidation. In other words there is not time enough between the melting and the depositing of the metal for the spray to absorb oxygen or other gases. Schoop has repeatedly demonstrated that he can fuse and spray lead by means of a stream of heated oxygen and yet obtain a normal, homogeneous layer without the slightest trace of oxidization.

A good idea of what the inventor has accomplished in the course of his ten years of labor can be had when it is recalled that his original apparatus weighed something like a ton while the latest of his pistols can be carried in the hand and weighs but 3.3 pounds. The electro-pistol consumes 40 amperes of current at from 25 to 30 volts; and to project the molten metal requires about 17.6 cubic feet of compressed air per minute. The gas pistol is of about the same weight, and both mechanisms are so light that the workmen can hold them and direct them with facility and without fatigue for a considerable period.

Agreeably to service demands, the whole metallizing equipment is built for portable or stationary use. For outside work, the plant is mounted on a small truck which can be



A complete portable outfit for the operation of a Schoop metal-spraying electro pistol. On the truck are mounted an electric motor and a direct-connected rotary air compressor together with an air reservoir. In this case there are two spools of metal wire to form and to feed the electric arc. The fused wire is blown by compressed air against the surface to be coated at a pressure of three atmospheres. The volume of the air can be regulated by the artisan agreeably to the surface to be covered and the metal which is being melted for spraying.

moved wherever desired. A skilled operative can galvanize or otherwise coat more than a square yard of surface in the course of six or seven minutes.

At the present, the principal function of the Schoop metal-spraying process is for galvanizing; and it is likely that its largest field will be in this direction for some years to come. In Switzerland, in Germany, in France, and in Italy coating with zinc in this manner is increasing rapidly. About two years ago, the Swiss Government adopted for its railways this method of galvanizing, and has employed it on the electrified section of the St. Gotthard railway for the protection of its transmission towers and spreaders.

Furthermore it has been found desirable to galvanize in this fashion certain railway bridges and the underbodies of fully 20,000 cars. The thickness of the zinc coating varies from .003 to .005 millimeters. The galvanizing of the underbodies of cars on railway and trolley lines safeguards them against rust and is believed to be greatly superior to paint. Indeed, abroad, the opinion is growing that it will pay to galvanize rather than to paint. We are told that objects apt to corrode rapidly because of their exposed positions, such as pontoons, buoys, shafts, lock gates, iron structures, etc., should not only be galvanized but given, besides, a coating of lead over that of zinc. This is also true of bridges where the metal work is in the path of exhaust gases from locomotive smokestacks. It is reported that the cost of so protecting surfaces—including metal, electric current, compressed air, and labor—does not exceed two francs per square meter, and the work can be done rapidly.

The potentialities of the Schoop process in the electro-technical and the electro-chemical fields are extremely interesting. There is, for instance, the partway coating with copper of high-tension, porcelain insulators—the object being to obtain increased safety or security in operation. The municipal electric plant at Stockholm, Sweden, has incorporated no fewer than 25,000 of these insulators in one transmission line; and a porcelain factory at Hermsdorf steadily employs a number of Schoop pistols for the treatment of these electrical fixtures. The method insures excellent contact surfaces; and this is a matter of no little consequence especially wherever transmission resistances are to be held as low as possible.

Chemical vessels of many kinds are now being coated with metal in the same way. For instance, iron containers are thus protected with an aluminum deposit and are proving satisfactory substitutes for those made wholly of aluminum. Similarly, lead surfacing by means of the metal-spraying process is found to answer even better as a defense against the corrosive action of acids. Metal coating of wood and pasteboard is said to be effective in halting the destructive work of white ants in tropical regions. Copper and aluminum-surfaced aprons and dresses are to-day employed in chemical plants where combustible fabrics would otherwise become impregnated with chemicals and expose their wearers to grave risks in the presence of an open flame. Abroad, the inner surfaces of beer kegs have been sprayed with aluminum instead of with the pitch hitherto commonly used.

It will surprise no one to learn that Schoop pistols are being relied upon right along in Europe to coat with aluminum the blades of airplane propellers. Wooden tobacco pipes have been similarly and successfully metallized in a large German factory; and in the realm of art and decorative features generally the application of the method is unlimited. As a matter of curiosity, perishable fossil remains have been sprayed in this fashion and made immune to atmospheric action without in any way marring the structural details.

One of the most significant adaptations of this system of protective coating has been in the case of the buckets of Pelton wheels in a Swiss hydroelectric station. While it has been the practice to arrest the flow of driftwood, etc., still the screens employed have not sufficed to block the passage of sand and gravel, and these abrasive materials have a tendency to wear away the buckets more or less quickly. This harmful action can be effectually checked by coating the blades with lead. Experiments have shown that the lead-filmed buckets, when deliberately attacked by a sand blast, are peculiarly resistant to the erosive effect of the abrasive. The explanation is that the impacting sand serves actually to hammer the lead more deeply into the rough surface of the bucket casting.

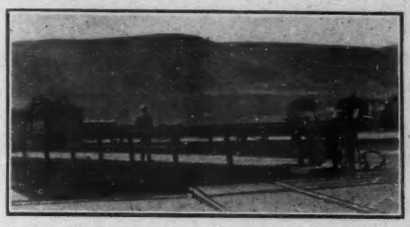
There has been developed for the treatment of large quantities of small articles a special machine with a rotating drum into which the commodities are placed. The spraying can be done either by fusing wires or by using powdered metal. The revolving drum is formed with spiral ribs or shoulders upon its inner surface, and these turn the objects so that every part of them can be coated uniformly. To spray something like 200 articles takes only twenty minutes, and they come out beautifully finished.

The spray pistol is so attached to the supporting shaft of the drum that it can oscillate, and this insures the widest distribution of the metallic stream. The same equipment can be utilized in the first place to sand blast the commodities in order to clean them before coating. When this apparatus is used for galvanizing it seems that the zinc penetrates into the deepest pores and interstices of the castings, forgings, etc., and forms a smooth and unbroken surface. This coating is so bound to the supporting metal that it will remain unaffected by hammer blows and considerable bending.

Some of the largest electrical and engineering concerns abroad have permanently adopted Schoop metallizing pistols for a variety of services too extensive to enumerate here. The process renders it practicable to galvanize and virtually to metal plate structures and objects that could not be dealt with by existing galvanizing and plating facilities. Finally, where the acids necessarily used in plating would be destructive to certain metals, these same substances can be effectually and successfully coated by the Schoop method. In many directions metal spraying bids fair to supplant painting, as the metal coating is much more durable than any mixture of oil and pigment.

AN 80-FT. TURNTABLE OPERATED BY AIR

THE illustration below shows an 80-foot turntable which is operated by compressed air. The air drives a rotary motor which is geared to the drivewheel. An air storage tank, as shown is carried along the side of the turntable, the tank being connected with piping down through the center of the turntable in such a maner that it receives the air supply regardless of the position of the



A locomotive can turn itself on the table.

table. An extra rotary motor is kept on hand, which insures the operation of the turntable, in case one motor needs repairs. A novel feature of this air driven turntable is the fact that there is an air hose shown at the extreme right, which is connected with the storage tank and provided with a quick connection by means of which air for operating the table can be obtained from the locomotive which the table is turning, in case the other source of air supply is exhausted.

HIGH ROTATIVE SPEEDS

A British tool making firm has been constructing grinding heads for small internal grinding in which the spindle is required to rotate at about 45,000 r.p.m. It is not such a simple thing as would at first appear to produce such speeds, which are beyond the limits of ordinary belting. One of these grinding attachments has been tested in the National Physical Laboratory in order to show that this speed is really obtained. The drive is by means of a stretched rubber band and at speeds of about 20,000 to 30,000 r.p.m. it shows negative slip; that is, the grinding spindle runs faster than the speed given by the ratio between the diameters of the pulley wheels and the speed of the driving spindle. The spindle ran quite satisfactorily at 45,000 r.p.m., and even at this speed showed a slip of but one-sixth per cent. The makers have expressed a wish for a test upon a similar spindle running at 100,000 r.p.m., and this will probably be undertaken as soon as a suitable method of measuring the speed has been devised. For the drive, why not try a compressed air driven turbine?

Contract for the construction of a railroad from Nakuru, Kenya colony, northeastern Africa, to the Uasingisu plateau, north of Victoria Nyanza, has been awarded by the British Government. This line, when completed, will reach the greatest altitude of any railroad in the British Empire, the highest point on the line being more than 9,000 feet above the sea level. The new line will cost approximately $10,000,000.

BORING HORIZONTAL HOLES ON VERTICAL MILL

By F. A. McLEAN, Mem., C. I. M. & M.

IT SOMETIMES happens in shops doing a wide variety of repair work, that a piece will come in for drilling that is too large to be handled on any post or radial drill in the plant. Such jobs are always a problem, the successful solution of which, usually depends on the ingenuity and skill of the foreman in rigging up or adapting such tools and odds and ends as may happen to be at hand.

A case in point, which clearly illustrates the value of pneumatic tools for such work, is shown in the illustration. The brake ring on a large Corliss driven coal mine hoist was broken in service so badly that a new one was required. The casting for this ring or spider was between nine and ten feet in diameter and had to be bored and turned all over. This was done on a fourteen-foot boring mill and the next step was to drill 96, 13/16 inch holes through the ring (which was about 1½ inches thick) to permit the bolting on of wooden friction pads or shoes.

Owing to the large size and awkward shape of the ring casting, it was impossible to drill it on an ordinary drill press so that it became necessary to seek some other way of doing the work. The old method of doing a job of this kind would have been to use hand ratchet drills, and figuring on about twenty minutes per hole and adding the time lost in shifting the drill, setting up the "old man," etc., would have probably required the services of two men for about 32 hours.

After the friction pads were bolted in place they had to be turned to form a good seat for the brake band and it was finally decided that the best way of doing the job was to drill it on the boring mill, thus saving the time which would otherwise be lost in moving the piece to and from the mill and resetting.

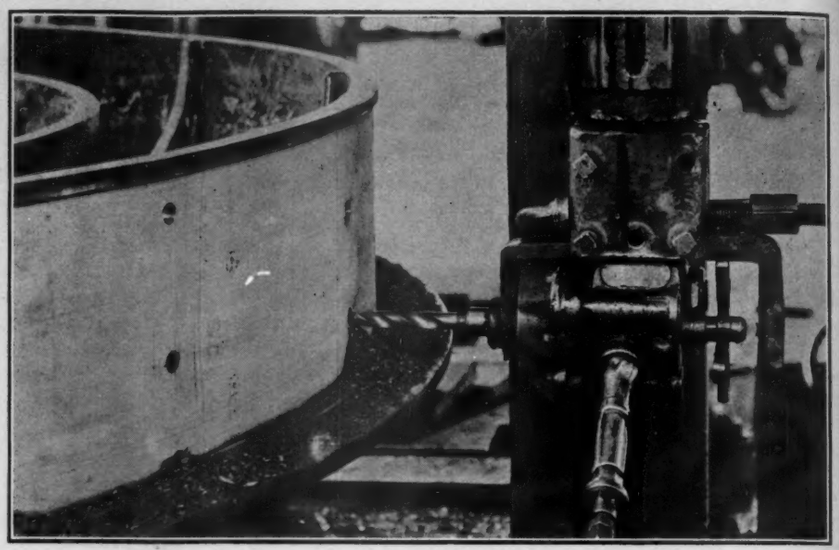


Fig. 2—Method of clamping pneumatic drill to boring toolhead so as to secure advantages of cross and vertical feeds. (No. 2 Little David Drill).

A small pneumatic drill was clamped to one of the tool heads of the boring mill by a simple yoke as shown in the figure. The cross and vertical movements of the tool head were used for feeding and adjusting the drill up and down, while the table was revolved from time to time, as required, thus acting as a sort of indexing device ensuring the proper location and alignment of the holes.

The actual drilling time using the equipment illustrated was eight hours for one man. The holes were all drilled true, little time being consumed in shifting the drill. One and one-half hours were saved in moving the casting to and from the mill and half an hour for resetting piece to turn brake pads after they were bolted on, thus saving approximately twelve hours over the estimated time required for two men to drill this piece on the floor.

It is obvious that the equipment shown in Figure 2 could be adopted to boring large horizontal holes by using a portable boring bar suitably geared to the pneumatic drill chuck instead of an ordinary twist drill. Such an arrangement would be of value in repair shops not equipped with a horizontal boring mill or where it is desirable to have both vertical and horizontal holes bored in large pieces at one setting.

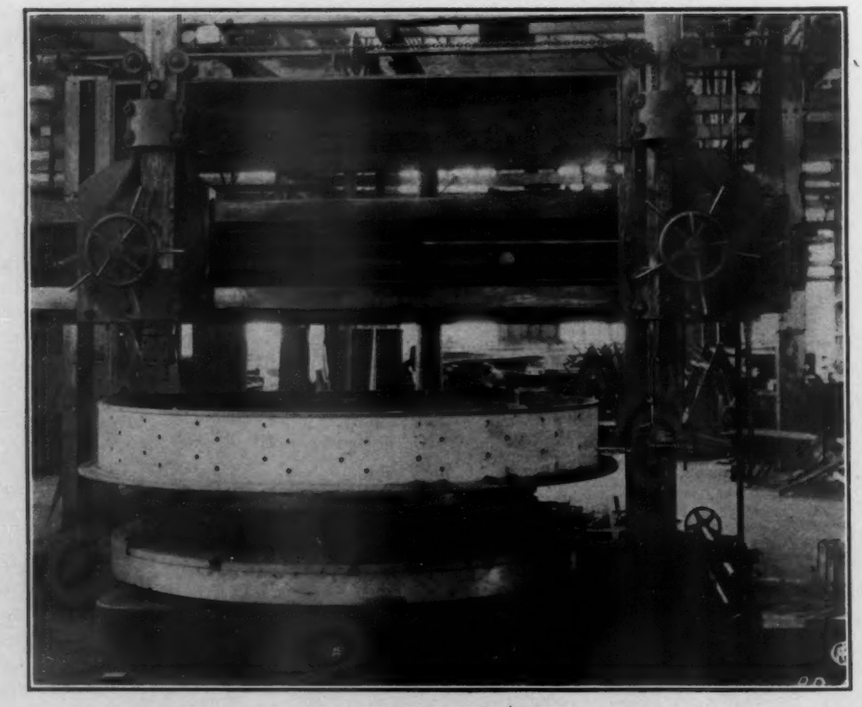


Fig. 1—Drilling horizontal holes in Corliss hoist brake ring on vertical boring mill with the aid of a small pneumatic drill. (No. 2 Little David Drill).

A GEARLESS STANDARD CRUSHER

The industries that make use of rock crushing machinery as an essential part of their operating systems are always interested in any development that promises either better results or lower costs. A machine has been developed as a secondary or recrushing unit, designed to produce finely crushed rock at a rapid rate and at low cost. The gears, heretofore an essential part of all gyratory crushers, were eliminated, and the driving power applied directly to the eccentric. The Kennedy Gearless Standard Crusher contains the well known ball-joint eccentric, which has been widely known as an important departure in gyratory-crusher design.

The direct drive has also been incorporated in the construction. The eccentric sleeve is made in two parts and is joined by bolts passing through at top and bottom.

The driving power is applied through a universal device that eliminates all friction and side strain due to the driving of the eccentric and relieves that grinding and side thrust common to all gyratory crushers. Oil from the eccentric chamber can flow freely between the balls, over the top of the pulley hub into the oil well inside the pulley.

This machine is made by the Kennedy-Van Saun Mfg. and Eng. Corp., 120 Broadway, New York.

Notes on the Use of Liquid Air Explosives

By EUGENE ROY

Chief Engineer, Societe de Pont a Mousson.

THE USE in Germany of liquid air explosives (already known and tried in other countries) was developed to a marked degree owing to the scarcity of nitrates caused by the blockade during the war which did not allow the usual shipments of Chilean nitrates to be made. The use of the Haber process for the manufacture of synthetic nitric acid was reserved exclusively for the preparation of explosives, and this factor certainly permitted Germany to lengthen her resistance. It therefore becomes interesting to consider the results which have been obtained with this type of explosive and what may be expected of them.

The first experiments were made in 1897 when the apparatus conceived by Linde for the liquefaction of air was already sufficiently improved to permit of obtaining liquid air in industrial quantities. More positive trials and on a larger scale followed from 1898 to 1905 during the drilling of the Simplon gallery. A little later, liquid air explosives were tried in the mines. In France they were successfully tried in the iron mines of the Briey district between 1909 and 1914 and particularly in the mines of Auboue and Droitaumont (Meurthe & Moselle).

During the war after making the necessary experiments, the use of liquid air explosives became general in the iron mines of Lorraine and numerous applications were made in coal mines, particularly in Upper Silesia.

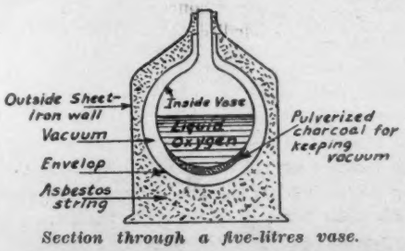
We will particularly consider the process of preparing and using this explosive, its advantages and inconveniences and finally, since the problem is for the purpose of obtaining liquid air economically, or to be more exact, liquid oxygen because it is this element of atmospheric air which is utilized, we will study the different systems which serve to produce liquid oxygen.

The explosive "substance" carries in itself all the elements of combustion of which oxygen is the most important component. More often the reaction of decomposition does not always result in a predetermined state of the elements entering into the reaction. The quantity of oxygen present affects to a great extent the nature of the resultant gases. This observation has a great importance when it concerns explosives to be used underground where the production of deleterious gases is a hindrance for the good performance of the work. When the oxygen is in excess, the combustion is complete.

Liquid air explosive is simply a combination of a combustible matter such as charcoal, lampblack, cellulose, petroleum, sulphur or aluminum, etc., soaked in liquid oxygen. Generally, the cartridges consist of a paper wrapper containing pulverized carbon such as lampblack intimately mixed with inert matter such as diatomaceous earth.

This cartridge is soaked in liquid oxygen right on the spot where it is utilized and just immediately before it is used. Up to the time of soaking, it is naturally evident that the cartridges and liquid oxygen carried apart, one from the other, do not offer the slightest danger. The cartridge if soaked and lighted in the open, simply burns very rapidly, and it only becomes explosive after having been tamped.

By varying the composition of the cartridge, one may at will vary the breaking capacity of the explosive. It is a curious feature which distinguishes it plainly from an explosive of definite composition. One may obtain slow effects by taking a combustible of coarse grain or by having the carbon diluted with inert matter, either diatomaceous earth or pulverized rock salt. The results then obtained can be compared to those of the so-called progressive powders such as black powders or the German *sprengsaltpeter*. On the contrary, one may obtain greater breaking effects by taking a combustible richer in carbon, more finely pulverized or further, by adding a metallic powder, the oxidation of which is characterized by a strong heat of formation such as aluminum for instance. We may then obtain breaking effects superior to those of all explosives known at present as dynamite or melinite. By varying the proportion of these materials in constant trials there has been worked out what is known as the "Weber" formula named after its inventor, an engineer of the firm of de Wendel of Hayange (Lorraine), for the manufacture of an explosive, the breaking effect of which is two and one-half times greater than that of dynamite.



Section through a five-litres vase.

The trials on the block of lead are instructive as shown in the illustration. Figure 1 shows the lead in trial block with a cylinder eight inches in diameter, ten inches high, drilled with a hole one and one-half inches in diameter and eight inches deep.

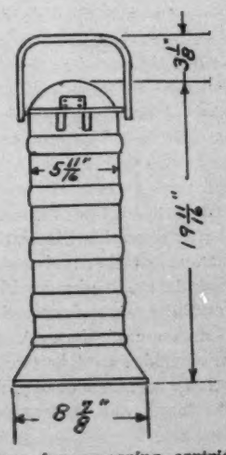
Figure 2 shows the effect of a load of six ounces of dynamite. Figure 3 shows the effect of a load of two and one-half ounces of liquid air explosive (Weber formula) where one sees that the bottom of the testing block has been carried away.

A comparison between Figures 2 and 3 needs no further comment. The greatest degree of detonation, hence the greatest breaking effect appears plainly in the case of the trial with liquid air. This formula seems to be particularly well adapted for the breaking of steel blocks.

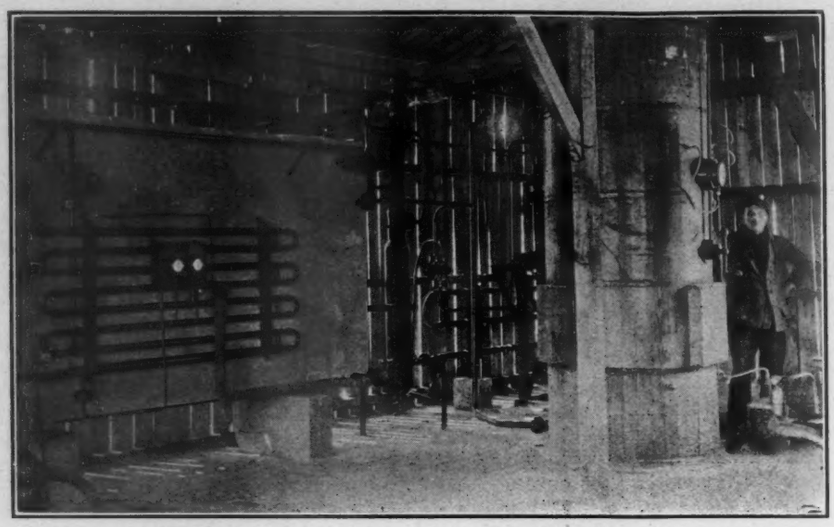
We have seen above that the soaking of the cartridge into liquid air must be done at the

Fig. 1—Showing lead block with hole drilled in center. Figs. 2 and 3 show respectively the effect of six ounces of dynamite and two and one-half ounces liquid air explosive.

Preparation of the cartridge before introducing into a drill hole, i. e., the soaking into the double wall vase containing the liquid oxygen.



Vase for preparing cartridges.



Coolers and the column of liquefaction used in the manufacture of liquid oxygen

time of using it. Liquid air in reality is obtained at a temperature exceedingly low (-190 degrees C.), about 310 degrees F. and therefore at normal temperature it evaporates rapidly. It is essential to operate rapidly and as quickly as possible. It is also necessary to shoot within several minutes after the soaking. After about ten minutes the cartridge loses its efficiency and may give no results. After half an hour it possesses no explosive qualities.

The necessity of performing rapidly the tamping and the blasting therefore does not allow of firing simultaneously a great number of holes. However it is possible to blast three or four mines at the same time and the better results of the explosive may easily compensate for this inconvenience.

The tendency of liquid air to evaporate causes a difficulty in transportation to the headings and this is one of the reasons which has retarded its use as an explosive. The problem is solved to-day by the use of special vases with double walls between which exists a vacuum. The loss by evaporation is about 0.5 per cent. per hour for the small vases of three to four gallons capacity and falls to 0.25 per cent. per hour for the vases of ten gallons capacity. Therefore these losses are not excessive and do not greatly increase the cost price.

The losses are greater at the time of pouring off the liquid into the soaking vase. It is not possible here to have the "slender collar" which reduces the evaporating surface. The soaking vase which is placed at the disposition of each miner is also a double-wall vessel made of sheet brass or silvered glass which may contain several cartridges. The miner pours out into the vase a certain quantity of liquid oxygen wherein he dips the cartridge to absorb the liquid for about ten minutes' time.

Some of the accompanying illustrations show the vases for transportation and soaking.

The following data will give an idea of the useful effect and the losses incurred in using liquid oxygen as an explosive: A three and one-half ounce cartridge absorbs two and one-half to three times as much of liquid oxygen. In counting the losses one may prepare three cartridges with one liter. To produce 100 liters of liquid oxygen, it is necessary to use seven pounds of caustic potash and five pounds of chloride of calcium for drying the air and 300 kilowatt-hours for the work of liquefaction. The effect produced by a liter of oxygen is more or less equal to that given by:

a—2.2 lb. of black powder.

b—14 oz. of dynamite.

With these figures and knowing each particular case, the price of explosive black powder and dynamite, the surrounding conditions and the price of electric current, it will be possible to figure the economy which may result from the use of liquid air as an explosive.

To sum up, the advantages of liquid air explosives are the following:

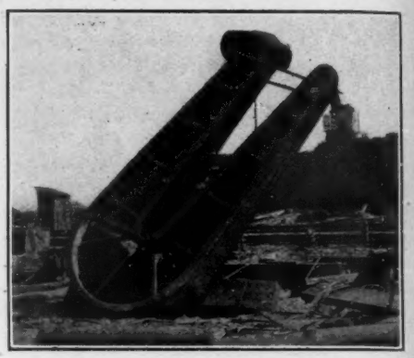
1. Possibility of adapting the explosive to the kind of rock which is to be blasted in varying the breaking effect.
2. Facility of manufacture of the cartridges.
3. Greater degree of safety in manipulation.
4. Absence of smoke and deleterious gases; combustion is complete owing to the excess of oxygen.
5. Unquestionable saving in every case.

We must just the same add that this explosive in its present state is not to be considered as a safety explosive in dusty or gassy mines and that its use in colleries where the combustible is scattered everywhere around will have to be watched carefully. Even with these reserves, its field of application is nevertheless of wide extent.

An aluminum bronze consisting of 84 per cent. copper, ten per cent. aluminum, five per cent iron and one per cent. of amalgamating alloy is being manufactured by the American Metal Products Co. and marketed under the name of "Ampco." It is made in various degrees of hardness, and is readily machined, forged and welded. According to reports it has a tensile strength of 75,000 to 100,000 pounds per square inch. One of the uses for this metal is for rings in turbo air compressors possessing acid-resistance qualities. The company has conducted numerous tests showing the effect of corrosion by various acids which will be gladly furnished on request.

A BIG WELDING JOB

THE pneumatic bull riveter shown in the accompanying illustration was in use for about three years before the break was discovered which afterward developed into a good, big chipping and welding job. It took one man seven days to chip out an average depth of four inches on each side, chipping out all flawed metal, on a "V" shape so as to enable the electric welder to do his welding. It took one welder twelve days to do this job and consumed about 25 pounds a day of welding rod or in other words 300 pounds in all. This crack or break, as some people call it, was caused by sand-holes in the casting. It is made of cast steel. The weight of the bull riveter is about 14,000 pounds. The welder used the Armco brand of welding rod and the machine used was the General Electric-balancer set. The chipping out of the flawed cast steel was done on both sides of the riveter and so was the welding. It cost in the neighborhood of about $250.00 to do this job, which amount included the chipping and welding, material and labor.

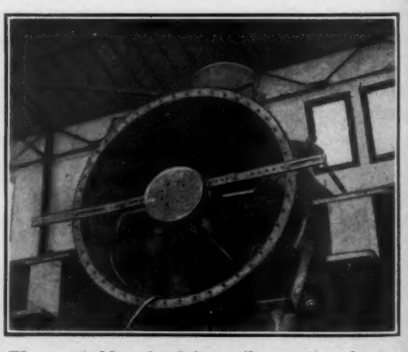


A crack in this 14,000 lb. bull riveter was completely welded.

AIR DRIVEN FLUE CUTTER

By C. W. GEIGER

The accompanying illustration shows a portable air operated flue cutting machine that is driven by an air motor. By means of this outfit any size flue can be cut out quickly and easily. The air motor and gear case, which gear the drill to the proper cutting speed, are both supported by adjustable cross bars which are bolted to the front end of the ring of the locomotive. A flexible shaft operated by the motor, carries the flue cutting device, which cuts the flue in one revolution.



The portable air driven flue cutter in operation.

PNEUMATIC PAVING BREAKER COMES TO LONDON

THE INTRODUCTION of pneumatic paving breakers in the British Isles has aroused a great deal of comment both from interested spectators and in the columns of various newspapers. Wherever these air driven machines have been in operation along the streets large audiences have quickly gathered, all being considerably impressed with the speed at which the breakers have torn out the concrete or other paving material.

That well known humorous weekly *Punch* has published a cartoon featuring the "paving breakers" with a suggestion that profit be made from the public's interest by charging an admission fee to see them in operation. The cartoon is reproduced on this page.

Other papers make various remarks concerning this new labor saver, as to its operation and economy.

Automatic Road Breaker at Work at Blackfriars

The Star, London, furnishes an interesting account from which we extract the following:

"The steam digger, which lifts a ton at once, has done much to lessen the labor, and now comes the road breaker, which smashes up asphalt and concrete as easily as cracking nuts.

It is an American invention and the machine is at work on a section of road outside Blackfriars station.

This paving breaker is cylindrical in shape, and at one end is fixed a steel chisel about eighteen inches long.

Inside is a piston or hammer, which is operated simply by a trigger throttle valve in the handle. The breaker weighs 68 pounds and requires two men to hold it.

In operation the chisel is driven into the dense concrete base on which the wood-paving blocks are laid. It bites off large chunks at a varying depth of six to twelve inches as easily as a man bites a crust of bread, and does it in a few seconds.

The flying particles of stone which accompany road-breaking when the chisel is driven into the road by sledge-hammers are wholly absent with the machine-driven chisel.

The shock of the blows is absorbed by springs.

'One machine-chisel will do as much as four chisels operated by gangs of sledge-hammer strikers,' said the engineer in charge to a *Star* reporter."

Pneumatic Road-Breaker, American Invention at Blackfriars

The London *Times* features the saving in that two men with this new machine can do the work of from four to five men working with hand chisels. They state:

"A pneumatic road-breaker, an invention from America, was to be seen breaking up the concrete foundations of New Bridge Street recently. In place of four or five men with heavy hammers, driving a chisel into the concrete, only two men are required to place this machine in position. The pick point is fixed into a vertical cylinder, and, forced by compressed air, fed through rubber piping from a portable compressor, an invisible hammer strikes the head of the pick point about 500 blows a minute, and under this great pressure it appears to slide into the concrete, which is broken into small lumps. It is claimed that one machine-chisel will do as much work in a given time as four chisels operated by navvy gangs."

Reproduced from *Punch* (London) by arrangement with the proprietors.

Suggestion to Borough Councils. "WHY NOT CHARGE FOR SEATS AND HELP TO LESSEN THE RATES?"

Automatic Navvy Makes "Mincemeat" of the Toughest Concrete

The *Daily Chronicle* announces and goes on to say:

"Chewing up the concrete foundations of New Bridge-street, Blackfriars, recently at the rate of 176 square yards in eight hours, an American pneumatic apparatus attracted crowds of city folk.

Instead of four or five muscular fellows swinging heavy hammers on to the head of a chisel two men are needed to place the machine in position, and the pick-point *slides* through a foot-thickness of concrete in half a minute!

A pressure of 90 pounds of compressed air, fed to the cylinder through rubber piping from a portable compressor close by, works the invisible hammer.

The hammer forces the pick-point through the concrete, and the vibration of the whole apparatus breaks up the concrete so that no lumps larger than a man's head are left."

The Road Eater

The *Express* calls it "The Road Eater, a machine that devours 24 square yards an hour," and states:

"The mechanical Jabberwock has come to town. Hundreds of lunch-hour loiterers gathered before Blackfriars Station recently to watch it chewing up the road at the rate of 24 square yards an hour.

Five hundred blows a minute are delivered by this dragon-like contrivance—a new road-breaker made by the Ingersoll-Rand Company. It does the work of a dozen navvies with pickaxes, and two men only are needed to guide its pointed bill along a concrete surface, into which it rips as easily as a hand-opener into a sardine tin.

A pressure of 90 pounds of compressed air, obtained from a tank above the apparatus, is fed through a hose to the breaker, inside which it operates a hammer. The resulting vibration of the pick-head scrapes up chunks of road as large as fair-sized cannon balls.

There was a comical contrast between the interested but otherwise listless crowd lounging against the barrier and the volcanic vitality of the insatiable road-eater."

CODE FOR COMPRESSED AIR MACHINERY

THE AMERICAN Society of Safety Engineers has been designated as sponsor for a Safety Code for Compressed Air Machinery by the American Engineering Standards Committee. The code will include rules for the construction and use of compressors, tanks, pipe lines, and the utilization apparatus where compressed air is the active agent. In accordance with the usual procedure, the code will be formulated by a sectional committee composed of representatives designated by the various bodies interested.

This work is being undertaken as part of a comprehensive program of safety codes in process of formulation under the auspices and rules of procedure of the American Engineering Standards Committee. The American Society of Safety Engineers was appointed sponsor for the Code for Compressed Air Machinery on the recommendation of the National Safety Code Committee.

Compressed Air Magazine

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EDITORIALS

HIGHWAYS FOR AUTOS AND AIRPLANES

OF ALL THE component parts of the normal human body the legs are greater than any of the others in weight and bulk, which may be considered a fact of the greatest and most wide reaching significance. The function primarily of the legs is that of locomotion, so that man is evidently meant to be on the go much of the time. As with the man individually so also is it with aggregate and collective man. In all the phases of human development in the mass the means and methods of rapid and facile conveyance of himself and his goods have always been most prominent, and never more so than to-day.

The history of the human race in peace and in war throughout all the stages of advancing civilization up to nearly the present could not be written without including the story of the horse. But that story is now coming rather abruptly to an end. He is dropping out of our sight and out of our planning, whether for the needs of business or of pleasure, and how long he may survive as the tool of the gambler is a question for time to determine.

And the horse is being superseded and discharged from our service not because we no longer have need of his services, but because he is so inefficient and so insufficient for our present and our rapidly growing demands, and because also we are developing other means of locomotion more powerful, more rapid and of vastly greater capacity in the aggregate.

Less than a century covers the entire history of the steam railroad, and the electrically driven railroad may be said to have begun with the present century. We have already gone so far with these as to begin to realize also their insufficiency and to be welcoming to our service a still later newcomer. The automobile is already relieving the railroads, taking up details of their work and at the same time making new business for itself, to an extent that few of us fully realize, and we have as yet scarcely begun to seriously employ it.

We have, however, already gone far enough with it to begin to perceive that it also is imperative in its demands for correct operative conditions if it is to be run with economy and satisfaction and with the certainty of unfailing employment. We cannot impose upon it as we could, and as, to our everlasting shame, we did impose upon the poor old horse. In railroading, the train must have its right of way and its track or it will not go at all. We shall have to realize that the auto also must have its road rights or it will soon be showing us in solid arithmetic how differences in cost for road construction and maintenance correspond inversely with differences in ultimate costs for speed and ease of transit. It has never been possible to measure in terms of hay or oats the horsepower of a horse in any specific case of work performed; the gasoline tank always makes absolute record for the auto. When we thus have the sure means of determining costs, and have our attention continually called to the matter we must inevitably develop the habit of considering what will pay and what will not pay, and then of insisting upon the establishing of the paying, and otherwise satisfactory, conditions.

No one needs to be told that a road surface of some kind is as necessary for the auto as is the steel rail for the locomotive to run on, but, unfortunately for the auto, and also for the road, it has not the means of insisting upon good conditions for road surfaces or of refusing absolutely to run where they are not provided; and so too many of them are running to-day where they ought not to, and we might easily imagine an active reciprocal recrimination, the roadways blaming the autos for the way they cut up and the autos cursing the roadways for not providing and maintaining the common necessaries of safe and comfortable travel.

Things cannot long go on in this way, for the auto will soon be in position to demand and to insist upon its rights. It is a fact of vast significance that in these days of lagging industries the Ford Motor Company alone is building passenger cars and trucks at the rate of 4,000 per day, which means more than a million a year, and still is increasing its manufacturing capacity as rapidly as possible.

These vehicles that it turns out will find employment not only in and around and between our big cities and the great centres of industry, where the roads are generally good and are tolerably well kept up, but they will, they do, spread all over the land and will be clamoring for good roads throughout our grand domain. We have four or five great transcontinental railroad lines which are functionally indispensable in our national life, and we may confidently predict transcontinental highways no less in numbers and capacity, with lines running north and south and ramifications connecting the several contiguous States and all the great centres of human life and activity.

These great highways must necessarily, and very soon, come to constitute a magnificent national system with similar conditions of construction and operation throughout, so that an auto, also standardized, could be at home on it anywhere and always ready to do its best both as to speed and as to cost of operation. Various rules for operating, with due regard for the rights of all, would necessarily be developed with means and ready authority for enforcing them. If, as we are contemplating them, the users of these grand highways of the not distant future are to be permitted to do their best upon them, there will be, within necessary limitations, practically no speed restrictions. Road surfaces must be kept in condition, grades made easy, curves lengthened and, in time, grade crossings, generally eliminated.

The providing of such a universal system of highways as the developing auto habit will require is an unavoidable task of the immediate future. It will be a waste of time to even consider the cost, since there can be no way of evading it, and since also the results secured will be of commensurate value and benefitting the entire community.

The value of the presumptive results does not at once appear. Having reached this point we cannot well withold the suggestion of the opportunity which the great continental highways will have, when established as in our mind's eye we see them, of incidentally rendering a service comparably as great and for which the world is waiting in another line of transportation.

The airplane is up to the present moment the culminating mechanical wonder of the ages. What it accomplished in war and what it has shown of its capabilities of performance in peace has made it impossible for us not to believe that it must become widely active and continuously serviceable in the future, unique and unapproachable in its isolated specialty. And yet for the time it is a distinct disappointment for the lack of a single facility most essential to its safe and successful operation. Generally speaking it has little difficulty in starting upon its flight without much preparation for its launching, or costly construction of platforms, and when under way it shoots along with little cause for anxiety and is comparably as safe as some other means of conveyance. The imperative requirement of flat areas of considerable extent and conveniently located upon which it can safely alight is the one thing lacking and which alone enforces its general inactivity.

As the canal must have its water, the railroad its lines of steel and the auto its well paved highway so must the airplane have its roomy landing fields wherever it is to have accustomed places of call. There could surely be no better location for them than along the lines of the established highways the continuous lines of roadway serving as a guide in flight and leading surely to the desired locations. These landing fields should parallel the roadways, lying close along side, a mile or two in length and of sufficient width. Provide the landing fields and the airplanes must multiply rapidly.—*R.*

COMPRESSED AIR IN THE BRITISH ISLES

COMPRESSED AIR is now more prominently before the British engineering public than it has been at any time in the past. Scientific institutions in various parts of the country are discussing its characteristics and various industrial applications with the result that all engineers agree that air power is in an unassailable position. Its progress in the mines and shipyards continues to be rapid, in spite of the gross wastefulness caused by defective pipes and equipment, and it has been proposed to form a committee to consider the question of metering the compressd air in collieries, as this metering is said to have resulted in substantial economies where it has been carried out. It is also stated that in the Pas-de-Calais in France a very great increase is taking place in the use of underground compressed air locomotives.

Some time ago a discussion on Mr. J. T. PRINGLE'S paper on "The Production and Transmission of Compressed Air in Mines" took place in Newcastle-on-Tyne and the remarkable recent progress of compressed air was pointed out. In the United Kingdom in 1919, there were 34 more collieries that had begun the use of coal cutting machines than in 1918, and 441 more coal cutters in use. Of these, 228 were driven by compressed air. In the Northern Division alone 1,025 machines were installed, of which 854 were driven by compressed air. At the time of the discussion mining engineers were still buying compressors, and the compressor manufacturers were very busy. It was concluded that much of the low efficiency of compressed air systems was due to incorectly designed pipe lines and avoidable leaks. Mr. PRINGLE discussed the various methods which could be followed to improve air efficiency in mines, and with regard to electric drills, agreed that what the mining world was waiting for was an electric driven percussive machine. He thought that the nearest attempt to that was the Temple-Ingersoll electric air drill, which was a six-horse-power machine without exhaust.

A debate on the subject of compressed air in mines was held at the Wigan Mining College in Lancashire. Three papers were read on the subject and various speakers followed, and compressed air found no lack of supporters amongst the practical mining engineers present. Mr. WEBSTER, the manager of the Long Lane collieries, said no one would deny that many grave dangers were avoided by the use of compressed air both on the surface and underground. These dangers included fire and explosions in dusty mines.

Compressed air had such an advantage in standing without loss ready at any time instantly to do work to the full limit of its capacity, and was so convenient a vehicle for the efficient transmission of power and so easy and safe of application, that its use is rapidly extending. For much work compressed air was not only the most economical, but the only possible medium of power transmission.

As usual a number of speakers pointed out how much of the reputed low efficiency of compressed air systems is due to avoidable losses in the systems themselves. Mr. A. WINSTANLEY, B. Sc., lecturer on mining, said that a compressed air system proved to be a robust and dependable source of power and not easily liable to damage. Systems in which there was compound compression, intercooling, correct pipe velocities, sufficient receiver capacity, and an absence of leaks, would show a satisfactory efficiency.

It may therefore, be seen that in England there exists among engineers a live progressive interest in the applications of compressed air, and an appreciation of its valuable aid in the reconstruction work now being performed.

A TUNNEL DRIVING RECORD

The following extract from a letter by F. C. Hickman in *Mining and Scientific Press*, September 24, 1921, will be read with interest and will be found entirely self-explanatory.

"I established what I think is a new United States record for hard-rock tunnel-driving last month, namely, 776 feet in schist and quartzite. The work was done at Priest Portal, which is part of the Hetch Hetchy project on the mountain division. Dimensions 11 ft. 3 in. by 11 ft. 3 in. Area of heading 106 square feet. An average of 28.3 lb. of 40% gelatine powder was used per foot. Ingersoll-Rand Leyner machines were used, three machines on the bar, and the Myers-Whaley mucking machines were used. Worked three shifts per day, and during the month 38 hours were lost on account of repairs and power failures."

The following records from COMPRESSED AIR MAGAZINE, September, 1917, are here reproduced for comparison. The character of the rock should be noted in each case.

The Elizabeth Lake tunnel on the Los Angeles aqueduct was driven 604 feet in one month through black shale.

The Red Rock tunnel, also on the aqueduct, was driven 1,061 feet in one month through cemented sandstone.

An 8 by 8 ft. tunnel, for the Arizona Copper Co., was driven 799 feet in one month through porphyry.

The Gunnison tunnel, 6 by 10½ ft., was driven 824 feet in one month through soft limestone.

The Mt. Royal tunnel, 8 by 12 ft., was driven 810 feet in one month through limestone.

The Laramie-Pordre tunnel, 7½ by 9½ ft., was driven 653 feet in one month through granite.

UTILIZING "WHITE COAL" IN FRANCE AND ELSEWHERE

FRANCE, as has been noted in these columns from time to time, has begun to awaken to the facts concerning her great economic neglect just before she was set upon in 1914 by her traditional industrial and military enemy. Since the Armistice, France has been looking about her fruitful domain. Engineers have noted that millions of horse power annually are running to waste, and it has come to these proverbially thrifty people as something of a shock. A survey of France's natural power assets was a consideration of the most imperative kind, for her destroyed coal mines, one of the chief sources of her former industrial prosperity, are still far behind in production, despite herculean efforts that have been made, and they will continue behind in production until 1926 at least.

There is a general feeling abroad that the French cannot make too great haste in converting all their water power into electricity to drive their industries. Accomplishment of this will mean greatly stimulated production and ensuing profits and a greater purchasing power in obtaining equipment and materials. The utilization of all this available force, and few countries are as well endowed as France in the number of her swift-descending streams, will mean the lessening by so much of the demand for factory and railway fuel, and place this fuel at lowered prices at the disposal of the general population.

It is probably not too much to say that nearly every country in the world could draw from its streams enough electric energy to propel the machinery of every industry that it now maintains or will establish in future. Power conservation experts in the United States have constantly reiterated this assertion. Only in the postwar period, however, has the world been coming to a fuller realization of what great stocks of energy still remain unutilized. France is now looking at the part employment of "white coal" power in America as an example of what may be done. On this side of the water there is mortification in many minds that we have not done more.

We have our Niagara Falls, producing hundreds of thousands of horsepower for nearby industry, and with potentialities of millions more without ruining the natural scenic effects of the falls. The American Geological Survey, we believe, has estimated the continuous natural flow of fluvial power alone in the country, if directly applied, at about 23,000,000 horse power. Maine, however, has already developed about 300 million hydro-electrical horse power per year, and both New York and California outstrip Maine, which by this means is regaining her old industrial position.

In a period of world rehabilitation after a war season of unequalled economic wastage and shrinkage, it is well not only for France, one of the chief sufferers, but for nations in all quarters of the globe to make use of power that still runs to waste. The present salvation of nations interlocked in either prosperity or distress, rests in economical provision for turning the wheels of industry.

THE SUPERPOWER SURVEY REPORT

THE REPORT of the Superpower Survey is something that every American should take to heart, for sooner or later we shall have to apply practically the conclusions drawn by the experts or fall behind industrially and commercially.

The present low tide in the business world has put our patience to a severe test, but the denials and even hardships that have been forced upon us by the productive ebb are slight in comparison with the difficulties that are sure to confront us in the future unless we can measure forces on more nearly even terms with our rivals in those foreign markets which have come to mean more to us than in the past.

Many of us do not know it, but the period between 1914 and 1919 compelled us to augment our manufacturing facilities to such an extent that our productive capacity is now 25 per cent greater than that required to meet the fullest of our domestic demands. The plant and equipment outlays represent hundreds of millions of dollars, and reimbursement of this overhead can be accomplished only by putting all of the machinery to work at a thoroughly profitable rate. In other words, we must run our shops and factories at maximum speed and find a ready sale for all of their wares.

But we cannot pursue this course to advantage unless we can obtain enough energy at a rate that will enable us to sell our commodities at favorable terms abroad. It is forced upon us that cheaper labor in other countries can be neutralized here only through the development of motive power at a cost considerably below that prevailing among our competitors.

The territory covered by the Superpower Survey is that area of the northeastern section of the United States lying between the 44th and the 39th parallels of latitude and reaching inland from the coast on an average of 150 miles. Within this zone is concentrated quite one-fourth of the nation's population, and in this vast beehive of intensified industry is made ready for the market 40 per cent in value of the country's total manufactures.

We are informed that the establishment of the contemplated Superpower System will enable us to reach in the course of the next nine years an operative stage that will cut down power costs annually a matter of more than $500,000,000 and make it possible for us to do a great deal more work while burning about 50,000,000 tons of coal less each twelvemonth.

As has been explained before in this magazine, the purpose of the Superpower Zone is to widen the employment of electric current and to distribute energy in this form rather than to transport coal for the feeding of a multiplicity of isolated steam plants. The principal users of energy generated by the proposed Superpower System will be the electric public utilities, the industries, and the heavy traction railroads. To benefit these several activities it is planned to interconnect as far as practicable existing electric utilities and to supplement these sources of power by linking them with master generating stations located at strategic points on our water courses or within easy touch of the coal fields.

The Survey has brought to a focus the notable difference between large and small units in the cost of power production. For instance, the power costs for plants greater than 100,000 kilowatts and those less than 1,000 kilowatts vary as three to one in the charge for fuel, while for maintenance and supplies the bigger plants are still more desirable in the ratio of four to one.

Within the Superpower Zone there are today 76,000 industrial establishments requiring mechanical power; and the average capacity of the isolated steam plants providing much of this energy is approximately 350 horsepower. The base-load steam-electric plants of the Superpower System will range from 60,000 kilowatts to 300,000 kilowatts, and none of the turbo-generators to be installed in them will be of less than 30,000 kilowatt capacity.

It should be of interest to note that the electric utility load in 1919 was substantially 10,000,000,000 kilowatt-hours; and if our industrial expansion continues at its normal pace the load will total 26,000,000,000 kilowatt-hours in 1930.

The Superpower transmission system will deliver current to its primary cables at 220,000 volts, and this will be stepped down to 110,000 volts for distribution over interconnecting lines. It is estimated that current can be transmitted at 220,000 volts over a radius of 350 miles at a loss of not more than six per cent. This makes it practicable to draw upon the Niagara River and the St. Lawrence, as well as upon stations in the Pennsylvania coal fields, for energy to be put to work within the Superpower Zone.

Out of the 36,000 miles of main line, sidings, and yards of the railroads in the zone, the experts of the survey are agreed that 19,000 miles could be electrified to advantage; and this system of traction would bring about an annual saving of $82,000,000.

The lesson to be drawn from the report is that there is waste and partway ineffectiveness in the independent operation of the numerous existing electric public utilities and most of the isolated industrial power plants.

LITTLE BELGIUM KEEPS GOING

WE HAVE been privileged to examine the official documents that record the public works which Belgium will place under contract within a short time. The facts and figures revealed by this examination reiterate the truth of the wise of saying that "standing still is going back."

Belgium does not intend to stand still. She will not have it that she move backwards. Her will is that she move forward only and that just as swiftly as a wise caution permits. The country is little, its natural resources are small, its determination to overcome its handicaps is prodigious, its spirit unconquerable and unquenchable.

Let us take a peep at these Belgian projected public works. They are all engineering projects and on a majority of them compressed air and compressed air machinery of the latest design and improvement will be employed, for wise Belgium has learned of the wonders that compressed air usage can work in the task of reconstruction and it is daily extending its compressed air practice.

The most important work is the construction of the Kruisschans lock at Antwerp at a cost of 80,000,000 francs. There are also to be constructed a canal at Antwerp, cost 90,000,000 francs, new docks at Austruweel, near Antwerp, cost 80,000,000 francs; large engineering work for diverting the rivers north of Antwerp, cost 100,000,000 francs; the construction of dry-docks at Ghent; the Antwerp-Ghent canal; a tunnel beneath the Scheldt; the construction of a fishing harbor at Ostend; the widening of the Antwerp-Liège and of the Limburg canals; the construction of canals in Limburg and Brabant for the transport of coal from the new mines of the Campine; the widening of the Charleroi-Brussels canal up to a capacity of 600 tons and so on and on and on. We have mentioned merely the leading items in the documents we have enjoyed the liberty of examining through the courtesy of Belgian Government officials.

There is a lesson here for us all. Belgium is living in the present only that she may translate herself into a more happy and more prosperous future. She is using every modern appliance and device which will assist her to accomplish that aim. Most of these devices come from America. American compressed air machinery is one of the chief items. Cautious speed is the Belgian watchword, all possible speed that is consistent with safety. Her feet are in the mud and woe of to-day but her eyes are fixed on the years to come. She is a far-ahead planner, for it will take from fifteen to twenty years to complete the works we have mentioned. Belgium intends that when challenged by the future she can stand forth efficient and fit, modern, healthful and helpful as fine a nation and as splendid a land as modern man, modern engineering and modern machinery can make her.

Reports received by the United States Bureau of Mines from companies operating copper mines throughout the country show that accidents during the year 1920 resulted in 128 deaths and 12,042 injuries, a decrease of 12 fatal and 194 nonfatal accidents as compared with the preceding year. The copper mining industry employed 35,254 men, who worked 11,182,119 shifts, which is a decrease of 4,073 men and 674,372 shifts as compared with 1919. Each mine employee averaged 317 working days, as against 301 the year before. The figures indicate a fatality rate of 3.43 (3.54 in 1919) and an injury rate of 323.07 (309.60 in 1919) per thousand men employed, based upon a standard year of 300 working days.

BOOK REVIEWS

PETROLEUM LAWS OF ALL AMERICA by J. W. Thompson, U. S. Bureau of Mines, Bulletin, 206. First Edition, March, 1921; 645 pp.; Price, 40c. Government Printing Office, Washington, D. C.

THE PUBLICATION of this most comprehensive and timely volume was the result of the wide demand for copies of the codes of the Central and South American Republics. MR. H. FOSTER BAIN, director of the bureau, in the preface takes occasion to remark that it was not practical to meet the demands for copies of these laws by persons interested in petroleum production and it was therefore suggested that the bureau collect and give to the public the laws regulating leases and concessions and the explorations for and exploiting of petroleum in these Republics.

Furthermore, the State Department yielding to the pressure of numerous inquiries and increasing demands for the information had undertaken through its consular service to compile these and other laws of interest to the American people. All of this material so collected by the State Department was very generously placed at the disposal of the Bureau of Mines.

This collection of laws is as current as it could be made considering all the difficulties involved, the time required for transmission of mail, etc.

This bulletin includes the petroleum laws of (1) United States; (2) the several oil-producing States; (3) Canada; (4) Mexico; (5) the Republics of Central and South America.

The author has sought to include the last congressional and legislative enactments on petroleum operations, and the laws given are the latest obtainable. No discoveries of oil have been made in some of the Central and South American Republic and those countries, therefore, have no laws on the subject.

For some countries, in the absence of a law governing petroleum operations, the general mining code is given, as it may be possible for petroleum concessions to be made and oil deposits developed under a mining code.

The petroleum laws of the Spanish American Republics are usually supplemented by decrees of the Presidents, which serve the purpose of regulations. These decrees may be issued at any time, and it is highly important for concessionaires to keep advised as to the latest decree. The same statement applies to the orders in council issued by the Canadian Government.

Much effort has been given to finding and presenting the latest and most reliable enactments. Every facility has been used in obtaining the most accurate translations of the Spanish laws. Different translations of some laws have been compared and the phraseology that seemed best has been adopted. A literal translation of every enactment has been sought, but some Spanish legislative expressions do not lend themselves to literal translation, and the intent of these has been gathered by persons familiar with Spanish legal terms and phraseology.

SHADES AND SHADOWS by DAVID C. LANGE, M. S. Instructor in Architecture in the Washington State College. Illustrated with plates and figures; 134 pp.; 5½x8½; price, postpaid, $2.50 net. New York: John Wiley & Sons, Inc. London: Chapman & Hall Ltd.

THIS BOOK gives a thorough knowledge of the subject of shades and shadows, so as to enable one to cast the shades and shadows of any object. The elements of descriptive geometry and the simplest methods of wash rendering are also included. Each step is taken up in succeeding articles, from the simplest to the most complex. The book makes the student think and reason through the proofs given, with the result that he is able to practically apply the knowledge gained, by working out a number of given problems illustrating the various articles. The general principles of shades and shadows including the details of illustrating points, lines, planes and solids are described and a concluding chapter is devoted to a discussion of wash rendering.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE, London. A report of proceedings of the Institute and containing instructive papers on various phases of the iron and steel industries. Vol. CIII, 1921. 480 pp. London: The Iron and Steel Institute, 28 Victoria Street, S. W. 1. Or New York: Spon and Chamberlain, 123 Liberty Street.

THIS VOLUME besides containing the report of the proceedings at the annual meeting held in London, May, 1921, gives notes on the progress of the home and foreign iron and steel industries as reported by scientific and technical societies. A bibliography of important works on the metallurgy of iron and steel, is also included. Among the topics discussed are the welding of steel in relation to the occurrence of pipe, blowholes and segregates in ingots; blast furnace and cupola slags and their composition; the prevention of hardening cracks and the effect of controlling recalescence in a tool steel; and spectographic investigations of iron and steel. The book is profusely illustrated, showing numerous photomicrographs, charts and other data.

The Colorado School of Mines has brought out the quarterly edition of the catalog and also a handsomely illustrated book of views showing the equipment, surroundings and activities of this well known mining school. The book of views together with the catalogue forms a very complete and interesting record of the work of this institution, located in the heart of a great mining country.

At the Northwest Experiment Station an attempt is being made to remove iron and silicon from kaolin to produce either sillimanite or the oxide of aluminum. Clay was melted in an arcing furnace in presence of carbon; some silicon and iron were volatilized, some reduced to metal. The products contained less iron oxide and silica and more alumina than previously, but not in sufficient amounts to be sillimanite. The refractoriness of these products is to be determined by the ordinary tests.

Training for Foreign Exploration was the subject of an interesting and valuable address by H. FOSTER BAIN, director of the United States Bureau of Mines at the 48th annual convention of the School of Mines and Metallurgy, University of Missouri, Rolla, Mo. The address has since been published in pamphlet form in the University Bulletin, June, 1921. The author points the way of meeting future demand for mineral products, first, by improvements in technology and financing to lower the limit of metal content which separates ore from waste and, second, to discover new deposits either of types long known or of new types. Mr. BAIN here refers to the "porphyry coppers," the search for which has led men in many of the odd corners of the earth.

The author's observations on the value of a knowledge of languages including Latin and Greek, long a much disputed question, will be found very instructive.

The Year Book (1921) of the Western Society of Engineers has been received. It contains a very accurate and up to date list of members, making the book very valuable as a directory of engineers. The book also lists the various officers and committees and gives general information on the object and activities of the society.

In the course of a paper on mining efficiency, read before the South African Institution of Engineers, Mr. F. C. W. Ingle said every mining engineer is aware that drilling machines were in use less than half the time the miner is underground, whereas actual drilling occupied less than one-quarter of the time. A hammer drill will drill on an average two inches per minute. The average footage drilled per machine shift is fifteen feet. In actual drilling time this would take 90 minutes. The balance of the time is lost in the miner getting to and from the stope, dressing and wetting down, rigging up and down, machine repairs, and by insufficiency of drill steel, breakages thereof, and failure of air and water supply.

New Mining Publications

THE BUREAU OF MINES of the Department of the Interior has published the following new bulletins and technical papers:

BULLETIN 185. Pennsylvania mining statutes, annotated, by J. W. Thompson. 1921. 1221 pp. Paper cover, $1.00. .....

BULLETIN 206. Petroleum laws of all America, J. W. Thompson. 448 pp. 40 cents. Reviewed in this issue.

TECHNICAL PAPER 269. Analyses of Iowa coals, by G. S. Rice, A. C. Fieldner, and F. G. Osgood. 1921. 27 pp. 5 cents.

NOTE—Owing to the expense involved in the preparation of these bulletins and the limited printing funds available for the use of the Bureau of Mines, it has been necessary to place on each bulletin the price designated. Orders should be sent to the Bureau of Mines, but should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D. C.

Results of work done at the Northwest Experiment Station in Seattle, Wash., indicate that fine grinding of sponge iron and wet magnetic concentration give a higher recovery of metallic iron than dry magnetic concentration on either coarse or fine material and that dry magnetic concentration is not improved by fine grinding. In melting sponge iron in a direct arc furnace using amorphous carbon as a carburizer, two and one-half per cent. carbon is readily reached with a practical limit of three per cent. Using graphitized carbon as a carburizer, three per cent. carbon is readily attained and four and one-half per cent. is easily possible.

The United States exported $535,560,000 worth of mineral oils during the fiscal year ended June 30, last, which was an increase of $109,000,000 compared with the previous year, as shown in a statement from the Department of Commerce recently. More than 3,000,000,000 gallons of this commodity went abroad during the year, about 200,000,000 gallons more than was exported during the fiscal year 1920.

In order to supply small quantities of distilled water, a unique evaporator is manufactured by the Griscom Russell Co., 90 West Street, New York. The set consists of an evaporator containing coils of brass tubing and to which steam is supplied. The vapor from this evaporator passes to a distiller and is condensed in the coils of this unit by circulating water which flows through the shell. The set is very compact and is mounted complete on an angle iron frame with the piping ready for the steam and water connections to be made to it. The dimensions of the complete set are only seven inches high by two feet four inches wide.

The Universal Portland Cement Co. announces a reduction in its selling prices for Universal Portland Cement, effective September 15, of twenty cents per barrel at its Chicago plant and fifteen cents per barrel at its Pittsburgh and Duluth plants. This is the second price reduction made by this company this year.

The Bureau of Mines has for some time past been conducting research work on drill steel at the Rollo, Mo., and Minneapolis stations, and it has been found that the practical application of drill steel has not kept up with the improvement in drills. In order to give this matter the attention it deserves, the Bureau of Mines and Bureau of Standards have extended an invitation to the following engineers to act as a committee to study the breakage and heat-treatment of steel: W. L. Saunders, Ingersoll-Rand Co.; Dr. J. A. Matthews, Crucible Steel Co.; Dr. Van H. Manning, American Petroleum Institute; F. W. Denton, Copper Range Co.; B. F. Tillson, New Jersey Zinc Co. Through this committee, and the Bureau of Mines and Standards working jointly, it is hoped that the subject will be given proper recognition.

The Dayton Air Brush Company was formed recently, with a capital of $25,000; the Pence Sealtite Battery Company was organized, with a capital of $1,000, and the Dayton Aluminum and Manufacturing Company increased its stock from $10,000 to $50,000.

Writing in the *Journal* of the British Chamber of Commerce, a traveler in South America says that he chanced to visit a little village on the Pacific Coast, where few people wore shoes and the generality of dwellings were made of mud and palm-thatch; yet an electric bulb swung in every hut, and the bare-footed laundress used an electric iron. The local sawmill was driven by electric power. A cascade on the village stream supplied this force, and indeed offered a surplus sufficient to fill the needs of a town of 100,000 people.

European Notes

The island of Madagascar is one of the richest in the world in precious minerals, according to Monsieur Lacroix, a celebrated French mineralogist, who presented a report on the mineral wealth of the island to the *Académie des Sciences*, at Paris, recently. During the last ten years, he said, the exploitation of the island's mineral resources has more than quadrupled. Garnet, corundum, beryls and tournmalines are found in largest quantities, although many other rare stones are extensively mined. The savant urged upon his colleagues of the *Académie* the necessity of spreading information as to the wealth of the island, which is a French possession, with a view to extending mining operations there, and in that way adding to the economic resources of France.

French engineers are keeping close watch on developments following the announcement of the discovery of a simple chemical process whereby petroleum is said to have been obtained from linseed and other vegetable oils. The discovery was communicated to the *Académie des Sciences* by Monsieur Mailhe, a well-known chemist. He reported that he had ascertained that by the application of suitable catalytic agents, of which nickel is one, the water and hydrogen of the oils may be broken up, leaving one or other of the aromatic compounds in a stable state.

It has long been a favorite project of Scandinavian engineers to harness for industrial purposes the enormous water-power potentialities of Norway. The obstacle to its accomplishment hitherto has been that even if these resources were turned into electric power there were few, if any, industries in Norway which could make economical use of them. Recently, however, a plan has been suggested for carrying the power to the adjacent parts of Denmark and Sweden, where cheap power can always be utilized, and progress is being made in its realization.

Portugal has mapped out an ambitious programme of reconstruction. The projects recommended concern mainly the development of the merchant marine service, railways, roads, irrigation and electricity. In a few words, the Government's programme is economy, hard work, increased production and quicker, more efficient distribution.

The contract for the construction of a bridge across the Yellow River for the Pekin-Hankow Railway has been awarded to the *Société Belge pour l'Exportation Industrielle*. The estimated cost is $10,500,000 Mexican. French firms gained the second and third awards.

A well-known Swedish mining engineer, M. V. Bergh, has applied to his Government for a subsidy in order to explore the possibilities of a newly invented method of utilizing aluminous shale. The shale is used for limestone burning and at the same time the raw oil is extracted by distillation at a low temperature. Mr. Bergh calculates that the cost of production of the raw oil is about ten *öre* per kilogram (roughly four cents) when the extraction is carried on at the rate of 45 kilograms of raw oil per ton of shale.

As Poland does not want to depend solely upon the port of Danzig, it is building a new port at Gdynia, a village situated on a strip of coast 120 kilometres wide, which Poland owns to the east of the Danzig region, Work is now sufficiently advanced to permit exploitation. The port is connected with the Polish railroad system, and there are plans for the construction of a canal which would connect it with the Vistula without leaving Polish territory.

The Lyons Fair authorities are organizing an Inter-Allied Congress of Apprenticeship. The Association for the Development of Technical Instruction, which numbers among its members the foremost French engineers, is giving its assistance. Questions for discussion relate to the recruiting of apprentices according to special ability, to the legal enforcement and control of apprenticeship, to regulations imposed by labor unions, to technical instruction and to apprenticeship premiums.

Italy is now making an energetic attempt to exploit her water-power resources. Up to 1915 Italy had 329 electrical stations with 835,000 horse-power. Since then 58 stations with 217,000 horse-power have been constructed and 57 stations with 599,000 horse-power are still under construction. Fifty-nine reservoirs with a capacity in excess of 225 million c. cm. effect the requisite water supply. Seventeen basins with a capacity of 701 million c. cm. are now under construction. The great basin at Tirso, in Sardinia, alone holds 400 million c. cm.

JULY 19

1,384,838. AIR-FEEDING DEVICE. John Y. King, Lansdowne, Pa.

1,384,898. APPARATUS FOR PRODUCING A VACUUM FOR VACUUM-CLEANING AND DUST-REMOVING PURPOSES. Bertram Charles Joy, Hempstead, London, England.

1,384,927. VACUUM-PUMP. Karl D. Smith, Battle Creek, Mich.

1,384,929. AIR-SEPARATOR. Thomas J. Sturtevant, Wellesley, Mass.

1,385,025. AIR-SEPARATOR. Thomas J. Sturtevant, Wellesley, Mass.

1,385,061-2-3-4-5. PUMP AND PUMPING SYSTEM. Burton S. Aikman, Milwaukee, Wis.

1,385,101. VACUUM-PUMP. John Twardowsky, Chicago, Ill.

1,385,134. FLUID-ACTUATED ROTARY TOOL. Francis A. Jimerson, Athens, Pa.

1,385,160. AIR-BRAKE SAFETY APPLIANCE. Henry C. Stokes, Sumter, S. C.

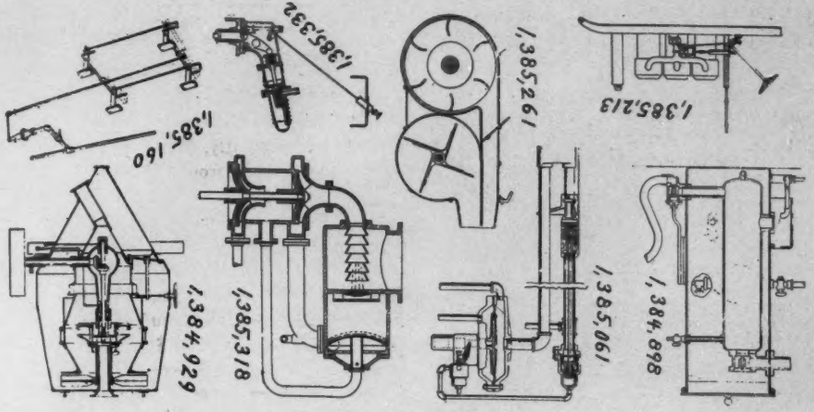
1,385,213. AUXILIARY AIR-FEED. Paul Emerson Kline, Bridgeville, Pa.

1,385,261. BLOWER. John William Muntz, Holgate, Ohio.

1,385,318. WET CENTRIFUGAL COMPRESSOR. Jens William Ægidius Elling, Christiania, Norway.

1. The process of compressing a gaseous medium, which comprises adding to the medium before compression an amount of liquid, compressing the mixture, separating part of the liquid from the mixture after compression, and returning the separated liquid to the compressor.

1,385,332. AIR-COMPRESSOR FOR MOTOR-VEHICLE TIRES. Marius Jean Baptiste Barbarou, Paris, France.



July 19.

JULY 26

1,385,458. DRILL. Henry J. Kimman, Cleveland, Ohio.

1,385,497. AIR-PUMP. Patrick M. Scanlan, Brooklyn, N. Y.

1,385,500. COW-MILKING APPARATUS. Warren A. Shippert, Chicago, Ill.

1,385,502. AIR-FILTER. Florence E. Smith and Fred B. Smith, Detroit, Mich.

1,385,573. VACUUM-CLEANER. Risaku Nishimoto, Tacoma, Wash.

1,385,676. MOLDING-MACHINE. Philetus W. Gates, Evanston, Ill.

1,385,706-7. AIR-LIFT SYSTEM. John Oliphant, Chicago, Ill.

1,385,708. AIR-LIFT BOOSTER. John Oliphant, Chicago, Ill.

1,385,751. MILKING-MACHINE INSTALLATION. John Sime Read, Eltham, Taranaki, New Zealand.

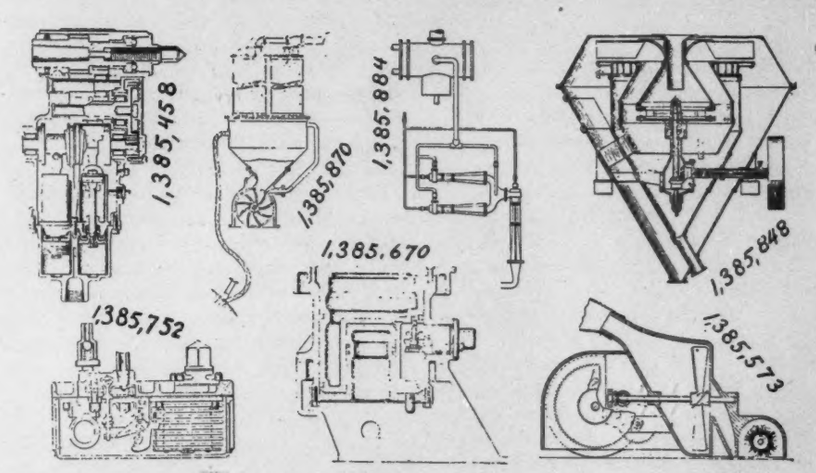
1,385,752. PNEUMATIC PUMP. Donald H. Reeves, Dayton, Ohio.

1,385,820. PNEUMATIC RIVET-PASSING APPARATUS. William B. Furman, Chester, Pa.

1,385,846-7-8. AIR-SEPARATOR. Thomas J. Sturtevant, Wellesley, Mass.

1,385,870. PNEUMATIC CONVEYING. George A. Gieseler, Cleveland, Ohio.

1,385,884. EJECTOR FLUID-PUMP. Sanford A. Moss, Lynn, Mass.



July 26.

AUGUST 2

1,386,006. GAGE. Charles S. Lawson, Pittsburgh, Pa.

1,386,009. FEEDER FOR POWDERED FUEL. John Urban McDonald, Decatur, Ill.

1,386,125. FUMIGATOR. Henry Loeb, New York, N. Y.

1,386,246. PULSATOR FOR MILKING-MACHINES. John G. G. Eklundh, Columbus, Ohio.

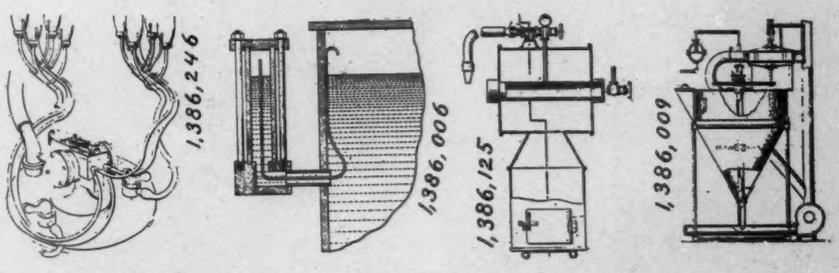
1,386,338. AUTOMATIC AIR-COUPLING. Eugene L. Horton, San Francisco, Calif.

1,386,498. MILKING-MACHINE. Palmer B. Hewlett, Hollister, Calif.

1,386,503. PAINT-GUN. Walter Kelly, Boston, Mass.

1,386,548. HIGH-PRESSURE SUCTION FAN AND BLOWER. Enoch J. Blackmon, Sherman, Tex.

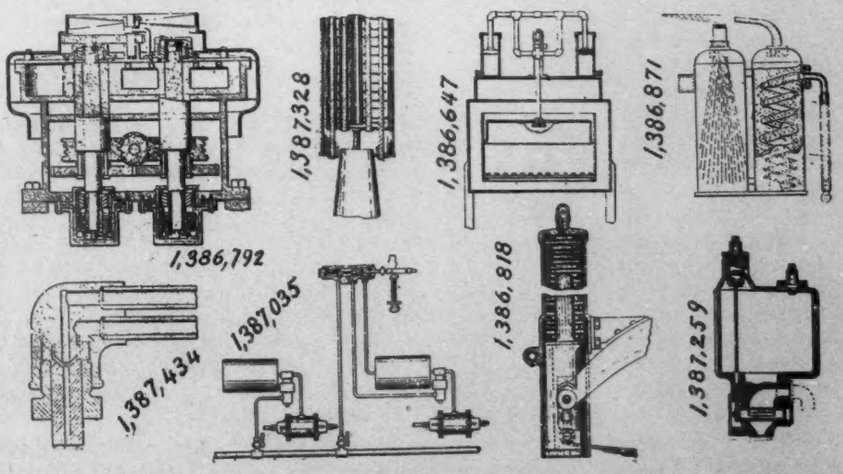
1,386,567. AIR-PUMP. John R. Hafstrom, Morocco, Ind.



August 2.

AUGUST 9

1,386,647. DRY-CLEANING APPARATUS. Albert T. Newman, Emporia, Kans.



August 9.

1,386,792. ROTARY BLOWER. John T. Needham, Bayonne, N. J.
1,386,818. PNEUMATIC SHOCK-ABSORBER. Charles T. Walter, Chicago, Ill.
1,386,871. BLOWTORCH. Charles H. Howell, Columbus, Ohio.
1,387,035. CONTINUOUS AUTOMATIC FLUID-PRESSURE BRAKE FOR RAILWAY AND LIKE VEHICLES. Arthur Morton Bell, Bombay, India.
1,387,259. GAS-COMPRESSOR. Joseph N. Hadjisky, Detroit, Mich.
1,387,328. AIR-PREHEATER FOR EXPLOSIVE-ENGINES. Samuel S. Staley and Mark W. Collet, Philadelphia, Pa.
1,387,434. BLOWPIPE. George L. Walker, New York, N. Y.

Dean W. R. Appleby of the Minnesota School of Mines has returned to Minneapolis from a three months' trip through Japan, Korea and Manchuria. Dean Appleby headed a party of mining engineers who were engaged by the South Manchuria Railway to investigate coal and iron-ore deposits.

* * *

Mr. Lloyd W. Chapman, formerly western editor of *Chemical & Metallurgical Engineering*, died recently at his home in Berkeley, Calif. Mr. Chapman was born in Pepperell, Mass., 34 years ago, and was graduated from Amherst Agricultural College. He specialized in chemistry and accepted a position in the laboratory of the Boston & Montana smelter at Great Falls, Mont. He was later connected with the du Pont company, but desiring to go West accepted the position which he held at the time of his death. He had many personal friends who will mourn his early demise.

* * *

Mr. Carl F. Dietz, vice-president and sales manager of the Norton Co., Worcester, Mass., has resigned to become president and general manager of the Bridgeport Brass Co., Bridgeport, Conn.

* * *

Henry J. Kimman, since 1902, manager of the Cleveland Plant of the Chicago Pneumatic Tool Company, died in Cleveland, Ohio. He was born in Harlem, Holland, in 1863 and emigrated to America with his parents and settled in Chicago in 1870. Being of a mechanical trend of mind he served his time with the Adams-Westlake Company and other manufacturing concerns in Chicago and the Far West. Through his varied connections his natural ability became fully developed until he could fashion anything of wood or iron. Like many self-made Americans his one ambition was to engage in business for himself and the start was made by converting the basement of his home on Nineteenth Street, Chicago, into a small machine shop, working days as a machinst for hire and working evenings for himself. Possessing a wonderfully imaginative mind he resigned and in collaboration with his brother T. P. Kimman built the portable piston air drill. Soon after engaging in the manufacture of air drills he became manager of the Cleveland plant and remained in active charge until his death.

COMPRESSED AIR IN AUTOMOBILE SERVICE STATIONS

IN THE EARLY days it was a mooted question whether air compressors were ever to be endured in garages, tire shops and service stations. When we look back even a few years and remember some of the curiosities that were in use under the dignified name of air compressors, we are not surprised that it required a long course of education to bring owners and proprietors of service stations to realize the fact that air service is not a luxury but a necessity of first importance.

The early "air pumps" were in most cases big, awkwardly constructed, slow running, belt-driven machines, which an occasional user would mount with a second-hand motor as a close-belted, motor-driven unit. Misapplication naturally resulted in unsatisfactory service, and it required a long season of educational effort to convince the motor car fraternity that there really is a difference between the "air pump" of the early days and the refined, automatically controlled, motor-driven air compressor of today.

Every branch of the motor car industry is selling "service." That service is most essential which tends to prolong the life of that item which represents the largest percentage of the cost of car maintenance—tires. The tire men are constantly driving home the fact that tires suffer far more from under-inflation than from over-inflation.

Many motorists have proved this themselves, and this has done much to transfer air service from the position of a luxury to that of an absolute necessity, without which no service station of whatever kind is complete. These motorists who are demanding air service are demanding efficient air service. A service station is advertised just as effectively by a dependable air system as is a restaurant by good coffee. It is the invariable rule that the garage superintendent or service manager who is negligent in regard to his air service is correspondingly so in other shop equipment.

Time was when there may have been some reasonable excuse for the existence of a service station without an air compressor. There was little to offer encouragement to manufacturers to develop compressors especially adapted to the service and little uniformity of opinion as to what kind of conditions would have to be met.

But the automotive industry is now as permanent as any other industry, and, thanks to the co-operation of the engineering department of the several branches of the industry, there exists a very clear understanding of what is good practice in the garage and service station equipment.

As the first move toward providing air service, careful note should be made of all possible uses to which the air may be applied where the compressor is to be installed. The old idea that its use is limited to the inflation of tires is absurd. It can be dispelled by spending an hour in any up-to-date garage or service station.

Air is ideal for blowing dust out of tufted car upholstery; used with a kerosene spray it provides a most efficient means of engine cleaning. With a small nozzle to concentrate the jet, carbon residue is readily removed from cylinders after burning out; mixed with gas by means of a compound blow-pipe, it produces an exceedingly hot point of flame for brazing or soldering.

By subjecting a radiator to even low air pressure, leaks are discovered that it would be next to impossible to detect with water; top and body dressings are applied by pneumatic atomizers. In paint shops the first or body coats can be applied in no way as rapidly and at the same time as effectively as by the air-brush method.

The foregoing are but a few of the many possible uses for air aside from the original one of inflating tires. It is a matter of prime importance that the compressor be of ample capacity. Get one large enough. It is evidence of lack of that self-confidence that is essential to business success, to fail to provide for growth in any business. Equipment is not bought for today, but for next year and the next year and the year following that.

Manufacturers of small compressors who have specialized in compressors for the automotive industry and have applied modern methods in doing so, are in possession of data enabling them to make reliable recommendations as to sizes of types of compressors best adapted to any given conditions.

The matter of lubrication is an important one. It seems to be the opinion of some users that "oil is oil," and many compressor complaints are directly traceable to the use of improper lubricants. The lubricating conditions found in compressor work very closely parallel those of gas-engine practice. Consequently, any high-flash point oil that is successful in a gasoline motor is suitable for a compressor.

The success of an air outfit depends largely upon the care exercised in installing, to prevent leaks in the system of which it is a part. An air leak represents a loss just as certainly as a gas leak, and should be stopped just as promptly. Particular attention should be given to the matter of valves and fittings to make certain that they are fitted for air. Pipe should be carefully threaded and the male threads well coated with lead and oil or litharge and glycerine before being screwed together.

A fitting closing thought is that of safety first. To save a paltry sum by purchasing a discarded or even a new range boiler for an air storage tank should be a criminal offense as endangering the public safety. Select a genuine air storage tank from a reputable concern, and get one tested to twice the working pressure that you find it necessary to carry. Then be sane in the matter of pressure. A pressure of 115 pounds is ample for the largest tires used on passenger cars, hence a pressure of 140 pounds or 150 pounds in the tank is ample for passenger car service.

For truck service stations which may eventually be called upon to serve 10-inch or 12-inch heavy-duty pneumatic truck tires carrying a maximum of 145 pounds in the tires, the use of extra-heavy tanks is advisable, with pressures ranging from 150 pounds to 175 pounds per square inch.